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Pp. 191–231 ; *Plates* 24–26 ; *4 Text-figures*

BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
GEOLOGY Vol. 3 No. 6
LONDON : 1958

THE BULLETIN OF THE BRITISH MUSEUM (NATURAL HISTORY), *instituted in* 1949, *is issued in five series corresponding to the Departments of the Museum, and an Historical Series.*

Parts will appear at irregular intervals as they become ready. Volumes will contain about three or four hundred pages, and will not necessarily be completed within one calendar year.

This paper is Vol. 3, *No.* 6 *of the Geological series.*

PRINTED BY ORDER OF THE TRUSTEES OF THE BRITISH MUSEUM

Issued February, 1958 *Price Fourteen Shillings*

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By WILLIAM THORNTON DEAN

SYNOPSIS

The history of the subdivision of the Caradoc Series in the type area is traced from the time of Murchison to the present day. The faunally defined Stages proposed by Bancroft are examined and redefined, and their relationship to established lithological units discussed. A new interpretation of the correlation between shelly and graptolite faunas is suggested, with some notes on the possible extension of the scheme to other areas.

I. INTRODUCTION AND ACKNOWLEDGMENTS

THE name " Caradoc " as applied to the succession of Ordovician rocks in south-east Shropshire originated in 1839 when Murchison, in his great work *The Silurian System,* gave the name " Caradoc Sandstone " to the strata cropping out along the strip of country between the Wrekin in the north-east and Coston, near Clunbury, in the south-west. Stratigraphically the beds lay between the igneous rocks forming the Church Stretton Hills and the Wenlock Shales. The clearest section was said by Murchison (1839 : 216) to be found in the valley of the River Onny near Horderley, which may thus be taken as the " type " succession. Unfortunately the beds assigned by Murchison to his " Caradoc Sandstone " included also horizons now known to be Pre-Cambrian, Cambrian and Silurian in age, and the basal quartzites of the Lower Cambrian were thought to be Caradoc Sandstone which had been altered by the " igneous traps " of the Church Stretton range of hills.

It was not until 1854 that any detailed subdivision of the Caradoc Sandstone was attempted, when Salter & Aveline published their classic results. Perhaps the most important of these was the proving of the unconformity, displayed in the so-called " Onny Section ", between what they termed the *Trinucleus* Shales (topmost Caradoc) and the overlying Purple Shales (Upper Llandovery). They divided the " Caradoc Sandstone " into five parts as follows, the youngest at the top of the table :

5. *Trinucleus* Shales
4. Flagstones of Cheney Longville, etc.
3. Sandstones of Horderley and Chatwall
2. Hoar Edge Grits
1. Shales of Harnage and Shineton

They failed to differentiate between the Shineton Shales (Tremadoc) and the Harnage Shales (Caradoc), but the two were separated later by Callaway (1877 : 653) who placed the Harnage Shales in their correct position above the Hoar Edge Grits, and gave them the stratigraphical name by which they are now generally known. In addition Callaway (p. 654) named Salter & Aveline's subdivision No. 3 the Chatwall Sandstone.

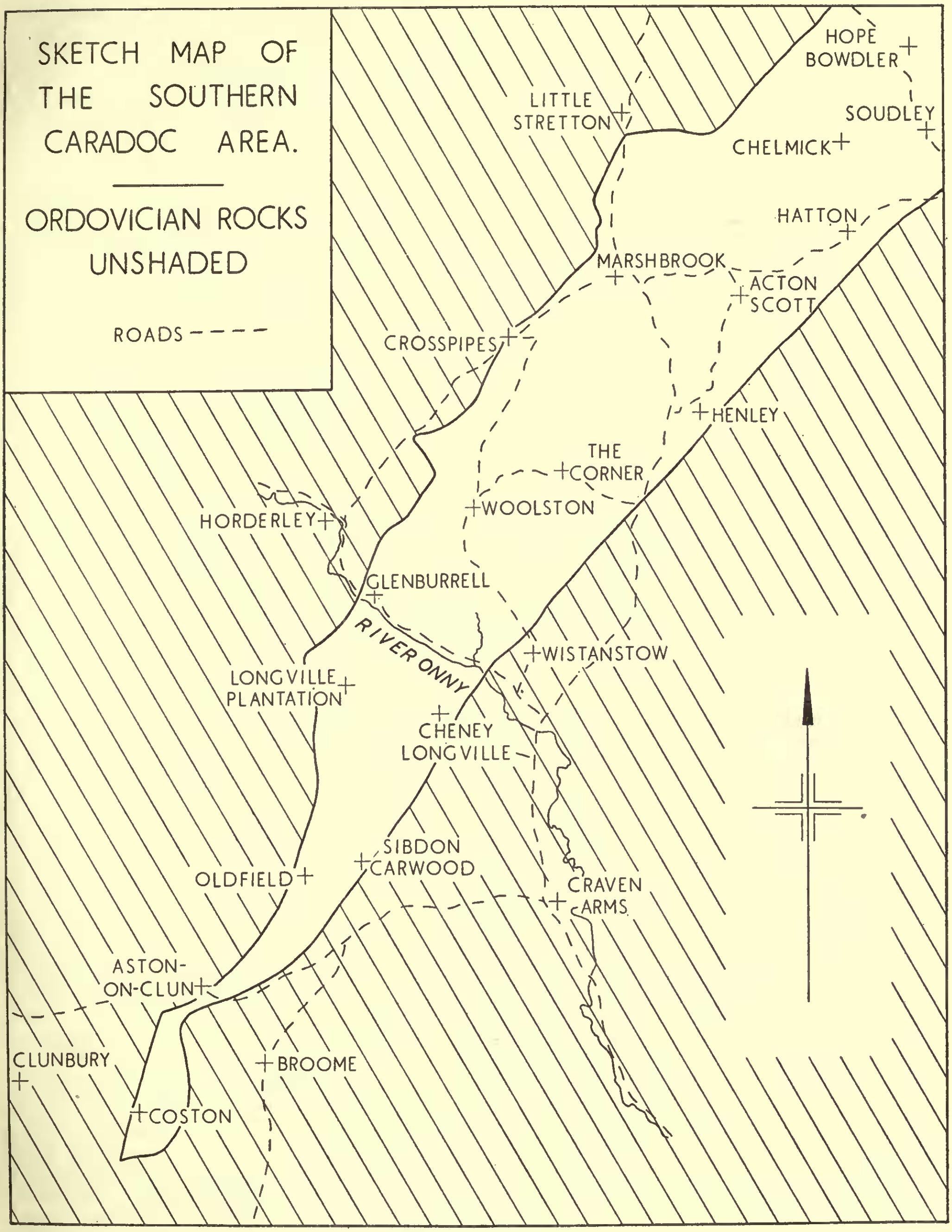
In 1884 the Shropshire geologist J. D. La Touche introduced the new names Horderley Sandstone, Cheney Longville Flags and Onny Shales, corresponding to Salter & Aveline's subdivisions 3, 4 and 5, and gave localities where the horizons might be examined. Ten years later Lapworth & Watts (1894 : 320) erected the name Acton Scott Beds for strata between the Cheney Longville Flags and the *Trinucleus* Shales.

No further modifications or additions were made to the succession until 1916 when Lapworth proposed the name " Caradoc Series " for the Ordovician strata concerned, and divided them into " Groups ", each being named after a locality in south Shropshire. The Groups were subdivided further but Lapworth gave neither type localities for his subdivisions nor any information regarding their distinctive lithologies and faunas. Nevertheless the Geological Survey has attempted to use Lapworth's subdivisions (Pocock *et al.*, 1938 : 81–90), but these are in need of more precise definition and will be examined in the following pages.

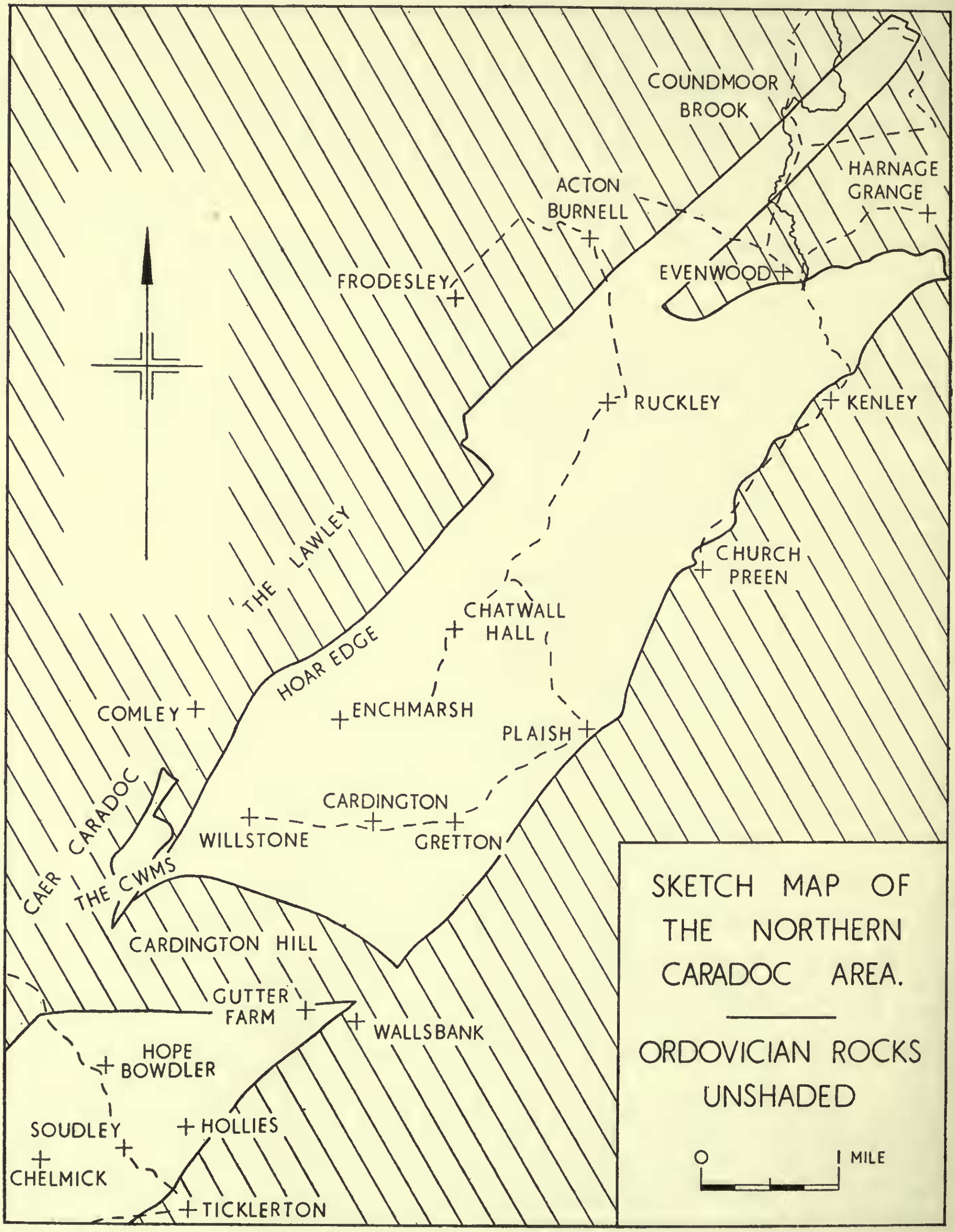
The most significant advance in our knowledge of Caradoc stratigraphy was made in 1929 when B. B. Bancroft published the first of a number of papers on the subdivision of the Series. All previous schemes of subdivision having been founded on lithology, Bancroft pioneered the splitting of the Caradoc succession into units defined by their contained faunas, in particular the brachiopods and trilobites. He erected the three Stages, Soudleyan, Longvillian and Marshbrookian (1929*a* : 33–35), but later listed seven Stages, Girvanian, Harnagian, Soudleyan, Longvillian, Marshbrookian, Actonian and Onnian in ascending order (1929*b* : table opposite p. 76). Four years later (1933) appeared a series of tables showing the distribution of the Stages Costonian to Onnian (the term Costonian not being defined, but replacing Girvanian), and listing both lithological divisions and zonal fossils. Many of the latter had not been described and were, therefore, *nomina nuda*. Additional data relating to Bancroft's Stages were published posthumously (1945) ; a correlation of the shelly and graptolitic faunas which was attempted is probably incorrect.

Much of Bancroft's earlier work did not receive the recognition it merited, due in part to the fact that many of his zonal indices had not, at that time, been described. In addition his results were marred by indiscriminate erection or suppression of subdivisions without sufficient description, and sometimes by inadequate diagnoses of critical fossils. Nevertheless, his pioneer work revolutionized research on the detailed stratigraphy of the Upper Ordovician strata in much the same way as did S. S. Buckman's on that of the Jurassic.

During recent work in south Shropshire Bancroft's major subdivisions, the Stages, of the Caradoc Series have been found to be applicable, though some emendation and redefinition are necessary in order to make the stratal classification more effective. The Stage will serve as a basis for the following account of the subdivisions, both large and small, of the Caradoc Series, and correlations with the graptolite zones will be re-examined. Correlation Tables and Plates of critical fossils are included.


SKETCH MAP OF THE SOUTHERN CARADOC AREA.
ORDOVICIAN ROCKS UNSHADED
ROADS
HOPE BOWDLER
SOUDLEY
LITTLE STRETTON
CHELMICK
HATTON
MARSHBROOK
ACTON SCOTT
CROSSPIPES
HENLEY
THE CORNER
WOOLSTON
HORDERLEY
GLENBURRELL
RIVER ONNY
WISTANSTOW
LONGVILLE PLANTATION
CHENEY LONGVILLE
SIBDON CARWOOD
OLDFIELD
CRAVEN ARMS
ASTON-ON-CLUN
CLUNBURY
BROOME
COSTON

TEXT-FIG. 1.


COUNDMOOR BROOK
HARNAGE GRANGE
ACTON BURNELL
FRODESLEY
EVENWOOD
RUCKLEY
KENLEY
THE LAWLEY
CHURCH PREEN
CHATWALL HALL
HOAR EDGE
COMLEY
ENCHMARSH
PLAISH
CAER CARADOC
CARDINGTON
WILLSTONE
GRETTON
THE CWMS
CARDINGTON HILL
GUTTER FARM
WALLSBANK
HOPE BOWDLER
SOUDLEY
HOLLIES
CHELMICK
TICKLERTON
SKETCH MAP OF THE NORTHERN CARADOC AREA.
ORDOVICIAN ROCKS UNSHADED
0
1 MILE

TEXT-FIG. 2.

The field-work upon which these results are founded was carried out from the University of Bristol during the tenure of a Post-Graduate Research Scholarship, for the award of which I wish to express my thanks to the Shell Petroleum Co. Ltd. Professor W. F. Whittard supervised the initial research, and I am also grateful to him for much useful discussion, and for reading and criticizing this manuscript.

II. THE STAGES OF THE CARADOC SERIES

(a) *Costonian Stage*

In the first instance, the strata constituting the Costonian were named the Girvanian Stage by Bancroft (1929*b* : 67, table opposite p. 76), and divided into five zones as follows :

5. *Horderleyella plicata*
4. *Harknessella subquadrata*
3. *Harknessella subplicata*
2. *Reedolithus subradiatus*
1. " *Orthis* " *confinis*

Of these, 1 and 2 were applied to the succession at Girvan, Ayrshire, 3 and 4 to the Cressage District, Shropshire, and 5 to the Horderley District, Shropshire. Such a composite succession, founded on faunal provinces so distinct as those of Girvan and south Shropshire, would appear to be unsafe ; it is not surprising that when next Bancroft (1933) published the succession comprising the Stage, and at the same time renamed the latter Costonian, he omitted the two lowest zones and retained only those three from Shropshire.

The name Costonian implies in itself the use of Coston, near Clunbury, as the type-locality, though Bancroft described it as being " typified by the grits of Horderley, Hoar Edge and Coston in the East Shropshire area " (1945 : 182). At Coston the succession is as follows :

	U. *Costonia ultima* Beds *nom. nov.*
Coston Beds *nom. nov.*	M. *Harknessella* Beds *nom. nov.*
	L. Basal Conglomerates

The type-area for the three new stratigraphical terms in the above table is the general vicinity of Coston Farm, one mile east-south-east of Clunbury.

No fossils have yet been found in the Basal Conglomerates. The succeeding *Harknessella* Beds contain an abundant brachiopod fauna of *Harknessella vespertilio* (J. de C. Sowerby), *H. jonesi* Bancroft, *Dinorthis flabellulum* (J. de C. Sowerby) and *Heterorthis patera* (Davidson), occurring in lenticular shell-beds. The *Costonia ultima* Beds represent Bancroft's Zone of *Horderleyella plicata,* and consist of thickly-bedded sandstones throughout which the fossils are distributed more or less uniformly. *Horderleyella plicata* Bancroft occurs throughout, though not commonly, but has not yet been found in significant numbers outside the Coston-Horderley District, and may prove to be no more than a local species. *Costonia ultima* suffers from similar limitations to its distribution, but the genus is more widespread. The topmost Costonian beds between the Onny Valley and Brokenstones have also yielded *Lichas* (*s.l.*) sp. and *Salopia salteri* (Davidson); the latter is predominantly a Harnagian species and a few specimens only are known from the Costonian.

Although Bancroft's Correlation Tables of 1929 and 1933 showed no subdivision of the *H. plicata* Zone, in a later paper (1945 : 235, 244) he referred to two subzones within it, those of *Smeathenella strophomenoides* Bancroft and *Dinorthis robusta* Bancroft. The order of superposition of these two was not at that time stated, but later Bancroft described the former as being the younger (1949 : 297). The usefulness of such a subdivision is doubtful, at least outside the Coston District, because the subzonal brachiopods have now been found associated at Brokenstones Quarry, a few miles north of Coston. *Costonia ultima* is present in the Upper Coston Beds of both Coston and Brokenstones, and constitutes probably the most useful zonal index but only within those districts.

In the northern part of the Caradoc Area the detailed succession within the lower beds of the Caradoc Series can be summarized as follows :

3. Rhynchonellid Grits
2. Sandy limestones with *Harknessella subquadrata*
1. Sandy shales and limestones with *Harknessella subplicata*

The lowest strata, constituting Bancroft's *Harknessella subplicata* Zone, contain a fauna of few species which, in addition to the zonal brachiopod, includes *Reacalymene pusulosa* Shirley and *Rafinesquina*, the interbedded shale-bands having yielded *Nemagraptus gracilis* (Hall). Beds 1 to 3 were placed in the Costonian by Bancroft (1933) who supposed them all to be older than the *Horderleyella plicata* Zone of Coston and Horderley. This age-relationship is considered here to be incorrect; Bancroft gave no explanation but he probably relied on the supposed equivalence of the strata with abundant *Harknessella* at Cressage and Coston, even though no species is common to both districts. Such a correlation, founded solely on large, shallow-water brachiopods apparently confined to marginal marine deposits, appears to be unreliable.

Near Harnage the trilobite fauna of the *H. subquadrata* Zone presents a picture quite different from that of the preceding *H. subplicata* Zone. *Decoroproetus* [*Proetidella* Bancroft], *Brongniartella*, *Eohomalonotus*, *Lichas* (*s.l.*) and *Costonia* sp. nov., of which the first two become more abundant in the basal Harnagian of the Onny Valley, are associated with *Reacalymene pusulosa*. The topmost beds of the so-called Hoar Edge Grits, that is those succeeding the *H. subquadrata* Zone and termed the Rhynchonellid Grits, are imperfectly exposed in the Harnage area, but at Stevenshill they contain, in addition to *Salopia salteri* and rhynchonellids, the diagnostic cryptolithid *Salterolithus*, and must be included in the Harnagian Stage, even though they immediately underlie the Harnage Shales (*s. s.*). There is no evidence whatsoever for the assertion that a considerable break exists between the Hoar Edge Grits and Harnage Shales of the Harnage area (Pocock *et al.*, 1938 : 86), and even the *H. subquadrata* Zone may best be regarded as showing signs of a transition towards the basal Harnagian, though the horizon must still be retained in the Costonian on account of the presence of *Costonia* and the absence of *Salterolithus* and *Reuscholithus*.

STAGE		CHARACTERISTIC TRILOBITE		CHARACTERISTIC BRACHIOPOD	LOCAL SUBDIVISION		MAX. THICK -NESS
ONNIAN	14	ONNIA SUPERBA		'RAFINESQUINA' HOLLI	ONNIA BEDS		50′
	13	ONNIA GRACILIS		ONNIELLA BRÖGGERI			60′
	12	ONNIA COBBOLDI		ONNIELLA INCONSTANS			40′
ACTONIAN	11	PLATYLICHAS LAXATUS		CRYPTOTHYRIS PARACYCLICA	ACTON SCOTT BEDS s.l.		190′
MARSHBROOKIAN	10	BROEGGEROLITHUS TRANSIENS	C	ONNIELLA REUSCHI	U	CHENEY LONGVILLE FLAGS	140′
			B	DALMANELLA UNGUIS			80′
			A	DALMANELLA WATTSI			75′
UPPER LONGVILLIAN	9	BROEGGEROLITHUS LONGICEPS	B	KJAERINA TYPA & DOLERORTHIS DUFTONENSIS	L		410′
			A	KJAERINA BIPARTITA	ALTERNATA LIMESTONE		65′
LOWER LONGVILLIAN	8	BROEGGEROLITHUS GLOBICEPS	C	BANCROFTINA TYPA	U	HORDERLEY SANDSTONE	150′
			B	DALMANELLA INDICA & D. LEPTA			
			A	DALMANELLA HORDERLEYENSIS	M		115′
SOUDLEYAN	7	BROEGGEROLITHUS SOUDLEYENSIS		REUSCHELLA HORDERLEYENSIS	L		280′
	6	BROEGGEROLITHUS BROEGGERI		SOUDLEYELLA AVELINEI	GLENBURRELL BEDS		140′
HARNAGIAN	5	ULRICHOLITHUS ULRICHI					
	4	SALTEROLITHUS CARACTACI			SMEATHEN WOOD BEDS		80′
	3	REUSCHOLITHUS REUSCHI & SALTEROLITHUS SMEATHENENSIS		SMEATHENELLA HARNAGENSIS & SALOPIA SALTERI			
COSTONIAN	2	COSTONIA ULTIMA		HORDERLEYELLA PLICATA	U	COSTON BEDS	35′+
	1	HARKNESSELLA - BEDS (TRILOBITES VERY RARE)		HARKNESSELLA VESPERTILIO & DINORTHIS FLABELLULUM	M		25′+
	BASAL CONGLOMERATES (NO FOSSILS)				L		45′+

TEXT-FIG. 3.—The Caradoc succession in the Onny Valley District.

It can thus be claimed, with some degree of certainty, that the *H. subquadrata* Zone of Cressage and Harnage is the equivalent of the *Costonia ultima* Beds (or *Horderleyella plicata* Zone) of Coston, at least in part. The *H. subplicata* Zone of Harnage may reasonably be equated with the *Harknessella* Beds of Coston. The strata containing abundant *Harknessella* would appear, then, to be diachronic, becoming progressively younger from south to north, and it is probable that the Basal Conglomerates of Coston may be the oldest members of the Caradoc Series in the whole Caradoc Area, and unrepresented in the Harnage District.

The so-called Hoar Edge Grits of the Cwms, east of Church Stretton, represent what is probably only a small portion of the Costonian succession, as trilobites found therein include *Decoroproetus* together with *Costonia* sp. nov. identical with that found in the *H. subquadrata* Zone of Harnage. The presence of *Salterolithus* in the same area indicates a Harnagian age for, probably, the uppermost part of the Hoar Edge Grits there.

(b) *Harnagian Stage*

The Harnagian was proposed by Bancroft (1929*b* : 67) and was said by him to extend from the summit of the Girvanian to the base of the Soudleyan. It was described merely as being characterized " by the *caractaci* group of *Cryptolithus s.l.*" (later *Salterolithus*). In the same paper (table opposite p. 76) he divided the Harnagian into four zones as given below, the two lower being described as occurring at Cound Brook (near Cressage) and Trilobite Dingle, Welshpool, and the two upper at Horderley and Trilobite Dingle.

Salterolithus caractaci
Salterolithus cf. *intermedius*
Reuscholithus reuschi
Salterolithus harnagensis

In a later work, however, Bancroft (1933) included only three zones in the Stage, the zonal trilobite of the topmost of these being at that time undescribed and, until 1949, unfigured :

Ulricholithus ulrichi
Salterolithus caractaci
Reuscholithus reuschi (misprinted as *Reuschella* [*sic*] *reuschi*)

It was in 1945 that Bancroft defined the type-locality of the Harnagian, stating it to be in the " Harnage Shales of Cound Brook, Cressage ", but he also defined the base as being marked by the appearance of *Reuscholithus* and *Salterolithus*.

Like those of the underlying Costonian, the strata assigned to the Harnagian Stage in south Shropshire are marked by changes in lithology along the strike, with their attendant variations in fauna. A further complication is introduced by Bancroft's fixing of the type-succession as the highly-faulted area of "Harnage Shales" in Cound Brook, near Evenwood, implying the inclusion of only the shale lithology at that locality. *Salterolithus* is described by Bancroft (1945 : 182) as being a genus especially characteristic of the Harnagian, and in the Evenwood District it first appears in sandstones immediately and conformably overlying others of definite Costonian age (see p. 198). It would seem advisable, therefore, to redefine the base of the Harnagian and to describe it as being marked by the appearance of the trilobite genera *Reuscholithus* and/or *Salterolithus*.

In the basal Harnage Shales of the Cound Brook section *Reuscholithus reuschi* Bancroft is abundant and occurs at, apparently, the same horizon as *Salterolithus harnagensis* Bancroft, both species inhabiting grey mudstones and, more rarely, sandy shales. Farther south, however, near the Onny Valley, *R. reuschi* is relatively uncommon, though attaining a larger size than at Cound Brook, and the basal horizon of the Harnagian is marked by an abundance of *Salterolithus smeathenensis* Bancroft and *Phacopidina harnagensis* Bancroft. *S. harnagensis* is not known from this area, and it is not surprising that Bancroft found it advisable to discard the *S. harnagensis* Zone in favour of using the single index *R. reuschi* for this particular horizon. As yet *Phacopidina harnagensis*, together with the uncommon accompanying form *Nieszkowskia stubblefieldi* Bancroft, has not been recovered from the Harnagian of Cound Brook, but *Primaspis* [*Acidaspis*] *harnagensis* (Bancroft) occurs there as well as near the Onny, together with rare *Decoroproetus* [*Proetidella*] *fearnsidesi* (Bancroft).

It has already been shown (p. 200) that the topmost part of the Hoar Edge Grits in The Cwms, east of Church Stretton, contains trilobites of Harnagian age, and on the nearby Hazler Hill basal Harnagian deposits form the infillings of the well-known neptunian dykes there. Details have been given of the fauna from these beds (Strachan *et al.*, 1948), but as long ago as 1929 Bancroft had stated that they were of the same age as his Zone of *Salterolithus harnagensis*, that is, basal Harnagian (1929*b* : 81). Apart from the large number of contained pebbles of Uriconian material, the lithology of the Hazler Harnagian beds is closely similar to that of the *R. reuschi* Zone in the Onny Valley, and the two may reasonably be equated. Certain differences exist, probably as the result of a shallower-water environment at Hazler, and the fauna there, while lacking most of the trilobites so abundant in the Onny Valley, includes the Baltic brachiopod genus *Vellamo*, a record new to Shropshire.

Bancroft's Zone of *Salterolithus caractaci* denotes an horizon stratigraphically higher than that of *Reuscholithus reuschi*. Although Murchison's syntypes were obtained from the Welshpool District, the zone was first established as a usable stratigraphical horizon in the vicinity of Glenburrell Farm, near Horderley (Bancroft, 1949 : 294). A large collection was obtained by Bancroft from the excavations that were dug here, and the material shows that there exists at this horizon in the Horderley District a large cryptolithid fauna consisting of one species, which seems best referred to *Salterolithus caractaci* (Murchison), though the latter has yet to be described adequately. Murchison's species has not been discovered in association with *R. reuschi* and its attendant fauna, and it seems advisable to retain the *S. caractaci* Zone as a separate unit. The state of preservation of the material from Bancroft's excavations is closely similar to that of the *R. reuschi* Zone in the Horderley District, and the *S. caractaci* Zone can be taken to represent the upper part of the yellow, blocky mudstones of Harnagian age which crop out at Smeathen Wood, just south of the Onny, and for which the name Smeathen Wood Beds *nom. nov.*

is here proposed. These comprise the strata in the Onny Valley belonging to the *Reuscholithus reuschi* and *Salterolithus caractaci* Zones, and the type-locality is the general area of Smeathen Farm, near Horderley.

The *S. caractaci* Zone formed the highest subdivision of the Harnagian as interpreted by Bancroft (1929*b*, table opposite p. 76), but in a later paper (1933) he introduced an overlying Zone of *Ulricholithus ulrichi.* Unfortunately the zonal trilobite was not then figured or described, and the name remained a *nomen nudum* until sixteen years later (Bancroft, 1949 : 295, pl. 9, fig. 14), although Bancroft had cited the species from Shropshire, Welshpool and North Wales (1933). He described Welshpool (1949 : 296) as being " the more important type locality " ; the text suggests that he had intended to formulate the species on a number of syntypes from Welshpool and from south Shropshire, but only an incomplete cephalon from Welshpool was figured by him ; this is the holotype (British Museum (Nat. Hist.) In. 42371). In the Caradoc Area the species is known from only two localities, both near Glenburrell Farm. Once again, a single cryptolithid species constitutes the whole trilobite fauna, and the writer accepts provisionally the existence of an *Ulricholithus ulrichi* Zone marking the horizon between the *S. caractaci* Zone and the base of the succeeding Soudleyan Stage, though the lateral distribution of the species in the remainder of the Caradoc Area has yet to be demonstrated. In order to do this, extensive excavations would be necessary as the strata, consisting of easily-weathered shales and mudstones, are almost invariably poorly exposed. Near Horderley they include the lower part of the Glenburrell Beds, comprising dark green mudstones and shales which are a continuation of the mudstone phase of sedimentation commenced in the Smeathen Wood Beds. The *Ulricholithus ulrichi* Zone is retained in the Harnagian because it contains no specimens of *Broeggerolithus*, the incoming of which genus indicates the base of the Soudleyan Stage.

Harnagian strata crop out elsewhere in the Caradoc Area, but the faunas are not so completely known as in the districts already mentioned. At the southern end of Ragleth Hill shales and limestones of Harnagian age rest unconformably on Western Longmyndian sandstones, but their exact zonal position is difficult to determine owing to the scanty numbers and poor preservation of the fossils.

Grey sandy shales exposed in the stream-section west of Wallsbank, on the south-eastern flank of Cardington Hill have yielded well-preserved specimens of *Reuscholithus reuschi*, and other, more fragmentary, material from the same neighbourhood suggests that at least one higher horizon may be present.

(c) *Soudleyan Stage*

The type-locality of the Soudleyan is not, as the name implies, at Soudley itself, but was defined by Bancroft (1945 : 182) as being " in the Onny Valley beginning in the Glenburrell Beds and terminating at the summit of the middle Horderley Sandstone ". The reason for this apparent anomaly is, no doubt, the superior series of exposures to be found throughout the Stage in the Onny Valley.

The name was first proposed by Bancroft (1929*a* : 33–34) to include " the highest beds of the Harnage Shale and the lower half of the Horderley Sandstone in Shropshire ". Faunally it was described as " corresponding to the upper part of the series with the *expansa* group of *Rafinesquina*, and especially characterized by a group of species of *Cryptolithus* in which the features of the *gibbifrons* group are modified or not fully developed ".

Later in the same year (Bancroft, 1929*b*, table opposite p. 76) the Soudleyan was listed in a table and divided into four zones as follows :

Dinorthis sp.
Reuschella horderleyensis
Cryptolithus sp.
Cryptolithus broeggeri

In 1933 Bancroft gave a rather more detailed succession for the Stage, dividing it into the following five zones :

Dinorthis multiplicata
Cliftonia persculpta
Broeggeria [*sic*] *soudleyensis* and *Reuschella*
Heterorthis retrorsistria, Broeggeria [*sic*]
Horderleyella and *Broeggeria* [*sic*]

The type-specimens of *D. multiplicata* Bancroft derived from near Glyn Ceiriog, where the species is relatively abundant and occurs with *Rafinesquina expansa*. It is not common in south Shropshire, and cannot be considered a satisfactory zonal fossil there. Of the other forms, *Cliftonia persculpta* is a *nomen nudum*, and Bancroft's genus *Broeggeria* has since been replaced by *Broeggerolithus* (Lamont, 1935 : 320). The two lowest zones were equated with part of what Bancroft termed the Glenburrell Beds, and the three highest with part of the Horderley Sandstone.

In the Onny Valley to the east of Horderley the series of mudstones already described under the Harnagian Stage continues upwards as far as the base of the Horderley Sandstone. The beds are well exposed in the sections behind and near Glenburrell farmhouse, which may thus be taken as the type-locality of the Glenburrell Beds. These consist of dark green mudstones, similar to those with *Ulricholithus ulrichi* at the top of the Harnagian. At Glenburrell they contain abundant *Broeggerolithus broeggeri* (Bancroft). The beds crop out in the bed of the Onny south-east of Glenburrell, and for a short distance to the south of the river. *B. broeggeri* is fairly common, and a good zonal index for the horizon ; it is accompanied by the characteristic brachiopod *Soudleyella* [*Onniella*] *avelinei* (Bancroft), with *Brongniartella* and a new, though uncommon, species of *Salterolithus*. When traced upwards in the Onny Valley the Glenburrell Beds become rather more arenaceous, and it is believed that these levels constitute Bancroft's Zone of " *Heterorthis retrorsistria, Broeggeria* " and, perhaps, correspond to the term " *Horderleyella* Beds " used by him in his description of *Horderleyella corrugata* but never defined (1945 : 238). The diagnostic species of cryptolithid is still *B. broeggeri*, and *Horderleyella corrugata* ranges upwards just into the lowest sandstones of the overlying Horderley Sandstone.

In turn the more arenaceous members of the Glenburrell Beds pass upwards into the lowest, flaggy strata of the Horderley Sandstone group, known to many geologists as the " *Glyptocrinus* Flags " on account of the abundance of the remains of the crinoid *Rhaphanocrinus* [*Glyptocrinus*] *basalis* (McCoy). In the Onny Valley these comprise greenish-brown, flaggy sandstones with lenticular shelly bands in which brachiopods, especially *Dinorthis*, *Sowerbyella*, *Rafinesquina expansa* and *Reuschella horderleyensis* Bancroft, predominate. Of the trilobites the most important is *Broeggerolithus soudleyensis* (Bancroft). Early forms of this species occur rarely in the *B. broeggeri* Zone (Bancroft, 1935 : 33), but *B. soudleyensis* occurs in abundance over most of the Caradoc Area in the zone to which it gives its name, and then disappears. The disappearance of this stock was only temporary, as related forms reappeared later, though not in large numbers, in the Alternata Limestone of the Upper Longvillian Substage (see p. 207).

As stated earlier, *Cliftonia persculpta* is a *nomen nudum*, and neither the *C. persculpta* Zone nor the *Dinorthis multiplicata* Zone of Bancroft has been found to be particularly valuable as a subdivision of the Soudleyan in south Shropshire. It is preferred here to make one *Broeggerolithus soudleyensis* Zone for the whole of the upper sandy portion of the Soudleyan in the Onny region, with *Reuschella horderleyensis* acting as a supplementary index (see table on p. 199). The *B. soudleyensis* Zone is considered to be broadly equivalent to the Lower Horderley Sandstone, the latter being used in a restricted sense, corresponding to the flaggy sandstones of the *Glyptocrinus* Flags of the Onny Valley. Bancroft used the term Lower Horderley Sandstone in a broader sense which is difficult to follow exactly in the field, including as it does both the flaggy beds and some of the overlying massive sandstones.

The most southerly outcrops of the Soudleyan in the Caradoc Area are found near Sibdon Carwood, west of Craven Arms, where quarries were opened in the " *Glyptocrinus* Flags ". These have yielded *Broeggerolithus soudleyensis*, *Soudleyella* and poorly-preserved graptolites. The Glenburrell Beds are not exposed in this area, but may be seen in the valley to the north-east of Hopesay Hill.

North of the Onny Valley, strata of Soudleyan age crop out near Brokenstones, but beyond this point they are cut out by faulting. They reappear near the southern end of Ragleth Hill, near Little Stretton, but only the upper arenaceous beds have been examined, the junction with the underlying Harnagian not being exposed. Similarly, near Soudley the lowest beds are not seen, but at Soudley Quarry the well-known purple and green sandstones are of Soudleyan age. These yielded the type specimens of *Broeggerolithus soudleyensis* and, as they are disconformably overlain by the Alternata Limestone (Upper Longvillian), the often used term " Soudley Sandstone " must be restricted to the upper part of the Soudleyan.

Palaeontological evidence suggests that the diachronism known from the earlier Caradoc strata is repeated in the Soudleyan, in the district north of the Cardington Hills. In the Onny Valley the lower zone of the Soudleyan, that of *B. broeggeri*, consists of dark green mudstones, followed by sandstones of the *Glyptocrinus* Flags (*B. soudleyensis* Zone). Both near Chatwall and The Cwms typical *Glyptocrinus* Flags are found to contain a form of *Broeggerolithus* close to *B. broeggeri* with *Rafinesquina expansa* and *Soudleyella* cf. *avelinei*. This fauna suggests an horizon somewhat earlier than that of the Zone of *B. soudleyensis*, a species not yet found in these beds.

(d) *Longvillian Stage*

The name was first employed by Bancroft (1929*a* : 34), who also termed it "*Kjaerina* Stage" and indicated that the lower and upper portions had distinct faunas; his description of the succession may be summarized as follows :

E.	Middle Longville Flags	
	E2. *Kjaerina geniculata* Beds or Zone	120 ft.
	E1. Laminated micaceous flagstones	165 ft.
D.	Lower Longville Flags	
	D1. *Heterorthis alternata* Beds (*Kjaerina bipartita* Zone)	110 ft.
C.	Upper Horderley Sandstone	
	C7. Green sandstones. *Wattsella* sp. D Super-zone	
	C6. Green and buff sandstones. *Wattsella* sp. C Zone	12 ft. +
	C5. Grey sandstone. *Kjaerina hedstroemi* Zone	Few ft.
	C4. Greenish and buff-grey sandstones. *Kjaerina intermedia* Zone	Few ft.
	C3. Grey sandstone. *Wattsella* sp. A Super-zone	*c.* 25 ft.
	C2. Green and purple sandstone	12 ft.
	C1. Buff sandstone. *Wattsella* sp. A Super-zone	18 ft.

Later in the same year Bancroft (1929*b*, table opposite p. 76) correlated some of these horizons with strata in North Wales, and divided the Longvillian into six "Zones and Super-zones" as follows :

Kjaerina geniculata Bancroft
Kjaerina bipartita (Salter)
Wattsella sp. D
Wattsella sp. C
Kjaerina hedstroemi Bancroft
Wattsella sp. A

Including as it did part of the Horderley Sandstone, together with the Alternata Limestone and the Lower Cheney Longville Flags, the Longvillian constituted a major and somewhat cumbersome subdivision of the Caradoc Series, and in a later work (1933) Bancroft found it convenient to subdivide the Stage into Lower and Upper Longvillian Substages. The dividing line was drawn at the base of the Alternata Limestone, and in the present account the two parts will be discussed separately.

Lower Longvillian Substage

When this subdivision was used by Bancroft for the first time, the previously lettered species of *Wattsella* were given names, though *nomina nuda,* and the following zones proposed :

Raymondella typa
Wattsella indica

Wattsella lepta
Wattsella horderleyensis and *Kjaerina*

The brachiopod faunas of the Caradoc Series in south Shropshire and part of North Wales were described by Bancroft in 1945. He did not recognize the fact that certain of the species, such as *Dalmanella horderleyensis*, *D. indica* and *Bancroftina typa*, had been described for the first time by Whittington (1938*a*, 1938*b*) who, although the names had first been used in manuscript by Bancroft, thus became their author.

In the present account it is recognized that a three-fold division of the Lower Longvillian can be established on the basis of the brachiopods as follows :

Bancroftina typa (Whittington)
Dalmanella indica Whittington and *D. lepta* (Bancroft)
Dalmanella horderleyensis (Whittington)

The beds with *Dalmanella horderleyensis* constitute the best-known strata of the Horderley Sandstone group, viz., the massive purple and green sandstones of Long Lane quarries, north-west of Craven Arms, and of the Onny Valley, east of Glenburrell Farm. The characteristic dalmanellid is abundant in lenticular limestone bands, with less common *Kjaerina jonesi* Bancroft and gastropods such as *Sinuites* and *Lophospira* cf. *gyrogonia* (McCoy). The overlying sandstones were divided into the separate zones of *Dalmanella lepta* and *D. indica* by Bancroft, but the evidence for the two distinct horizons is not altogether satisfactory and, for the present, it is proposed to group them together as one. The Shropshire syntype of *D. indica* came from Longville Plantation, whilst the type specimens of *D. lepta* were obtained from near the south bank of the River Onny, a mile or so to the north along the strike from Longville Plantation, and the division of the beds into two separate entities cannot be accepted as satisfactorily established. The succeeding beds are characterized by *Bancroftina typa* (Whittington), though *Kjaerina* also occurs in some numbers. A conspicuous feature of the fauna of the Lower Longvillian is the extraordinary abundance of *Sowerbyella soudleyensis* Jones, a form which occurs throughout the Substage and constitutes a large proportion of the lenticular limestones.

Tribolites are not uncommon in the Lower Longvillian, and include *Brongniartella*, *Eohomalonotus* (rare), *Phacopidina apiculata* (Salter) and *Reacalymene*. The most characteristic form is *Broeggerolithus globiceps* (Bancroft) which occurs throughout most of the Substage and is now taken as the zonal index. Bancroft recorded *Platylichas laxatus* from the highest strata with *Bancroftina typa*, but intensive searching has failed to substantiate this claim.

The sandstones with *Dalmanella horderleyensis* constitute the best-known building stone in the Onny Valley district, but at higher faunal horizons the beds become less suitable for building purposes, and are noticeably more flaggy, marking a transition to the overlying Upper Longvillian. Farther north, in the Soudley District, the latter beds rest upon sandstones of Soudleyan age, the whole of the Lower Longvillian being cut out by overstep.

Upper Longvillian Substage

In his first usage of the Substage Bancroft (1933) divided the beds into three brachiopod zones :

Kjaerina geniculata Bancroft
Raymondella gigantea—manuscript name
Kjaerina bipartita (Salter)

Of these, *Raymondella gigantea* is still an undescribed species and, hence, a *nomen nudum*. In practice it has been found most convenient to divide the Upper Longvillian into only two parts. The lower is represented by the Alternata Limestone, so-called from the abundance of *Heterorthis alternata* (J. de C. Sowerby), a species which forms lenticular limestones at this horizon throughout the Caradoc Area. The same brachiopod is known from higher horizons in south Shropshire and, for zonal purposes, Bancroft's practice of employing *Kjaerina bipartita* is preferred. Other brachiopods which appear to be restricted to this horizon are *Bancroftina robusta* (Bancroft) and *Marionites typa* (Bancroft), though not in such abundance.

The Alternata Limestone is not a single calcareous band, but consists of impersistent shelly lenses separated by dark green flaggy sandstones and siltstones. Passing upwards, the limestone lenses die out, and there is a transition to the rather monotonous series of green flaggy sandstones, known generally as the Lower Cheney Longville Flags. Fossils occur mainly on bedding-planes throughout the group ; *Kjaerina typa* Bancroft is abundant and is considered to be commoner than *K. geniculata*, the index-species chosen by Bancroft. Other brachiopods found in moderate abundance include *Dolerorthis duftonensis* (Reed) and a species of *Bancroftina* (possibly Bancroft's *Raymondella gigantea*), both of which occur throughout the beds with *Kjaerina typa*.

Trilobites are frequent in parts of the Upper Longvillian but only one form can be considered suitable as the zonal index. This is *Broeggerolithus longiceps* (Bancroft) a species which is more abundant in the flaggy siltstones separating the shelly lenses of the Alternata Limestone than in the lenses themselves. *B. longiceps* persists through the higher beds of the Upper Longvillian, but in reduced numbers. *Phacopidina apiculata* (Salter) is common in the Alternata Limestone, as is *Brongniartella bisulcata* (Salter), the *forma typica* of which appears for the first time at this horizon. *Chasmops* makes its first appearance in Shropshire in the higher beds with *Kjaerina typa*, and individuals of both this genus and of *B. bisulcata* often attain large sizes. An interesting feature of the trilobite fauna of the Upper Longvillian, at least in the Soudley District, is the reappearance of a form of *Broeggerolithus*, closely allied to *B. soudleyensis* (Bancroft), in which several pits of the outermost or E2 row on the fringe are missing in front of the glabella. Nothing like it is yet known between the Upper Soudleyan and the Upper Longvillian in south Shropshire, nor from any strata later than the Upper Longvillian. In the Llansantffraid-ym-mechain District of Montgomeryshire Whittington (1938*c* : 436, 451) records " *Cryptolithus soudleyensis* " from beds which are Lower and Upper Longvillian in age.

The Upper Longvillian follows the Lower Longvillian with apparent conformity in the Onny Valley, but farther north, at Soudley, it rests on the upper part of the Soudleyan. At Chatwall the Upper Longvillian may include at its base both conglomerates and sandstones which have been classified in the broad term of " Chatwall Sandstone " ; this problem is discussed later (see p. 216).

(e) *Marshbrookian Stage*

The Marshbrookian Stage was first adopted by Bancroft, who also gave the alternative name of *Kjerulfina* Stage, named after what he considered to be the typical brachiopod genus (1929*a* : 34). The lower limit was taken arbitrarily at the base of what he called the *Wattsella wattsi* Zone, owing to the fact that *Kjerulfina* appeared just below the summit of the Longvillian Stage. In the same paper (p. 39) he divided the Stage, which was described as being represented by the upper 130 ft. of the Cheney Longville Flags in east Shropshire, as follows :

F4. Transition Bed (*Kjerulfina polycyma* Zone)
F3. *Wattsella unguis* Beds (*W. unguis* Super-zone)
F2. *Heterorthina praeculta* Beds (*H. praeculta* Subzone)
F1. *Wattsella wattsi* Beds (*W. wattsi* Zone)

F2 was stated to be a subzone of F1, and, in another paper (1929*b*, table opposite p. 76), exactly the same subdivisions were again used. Bancroft claimed at first that the fauna of the Marshbrookian was unknown elsewhere, but subsequently (1933) he assigned strata in Westmorland, west Shropshire and North Wales to the Stage and proposed a subdivision into the following three zones :

Onniella reuschi
Wattsella unguis
Wattsella wattsi

Not until 1945 did Bancroft define the type-section of the Marshbrookian as being " through the highest beds of the Longville Flags as exhibited in the lane through Marsh Wood, half a mile south of Marshbrook Station ".

Although Bancroft appeared to attach most importance to the brachiopods as zone-fossils and used them in his first definition, in practice the fossil most characteristic of the Marshbrookian as a whole is *Broeggerolithus transiens* (Bancroft). This is not known from strata earlier than those lowest in the Marshbrookian, and extends throughout the Stage in moderate numbers. Further, with reference to the beds above the Marshbrookian, the absence of cryptolithids from the Actonian in Shropshire is conspicuous and helps to fix the boundary between the two Stages. The claim by Bancroft (1945 : 183) that *Broeggerolithus* disappears somewhat later than the base of the Actonian has not been substantiated in Shropshire, and may possibly refer to strata outside the county. Of Bancroft's zonal brachiopods, *Wattsella wattsi* Bancroft and *W. unguis* (J. de C. Sowerby), both of which are now referred to *Dalmanella*, appear to indicate successive horizons, but they have been found to overlap slightly, at least in the Marshbrook District. *Heterorthina praeculta*

Bancroft is characteristic of the lower series of beds, but as it occurs in small numbers throughout most of the strata containing *D. wattsi* its use as a subzonal fossil should be discontinued. The third index-brachiopod, *Onniella reuschi* Bancroft, appears to have some practical advantage, if not priority of publication, over *Kjerulfina polycyma* Bancroft as an horizon indicator, and is retained for the topmost brachiopod horizon of the Stage. Unless reasonably well-preserved, specimens of *K. polycyma* may be difficult to distinguish from *K. trigonalis* Bancroft, a species which is found only in the *Dalmanella unguis* Beds.

The type-section of the Marshbrookian, in Marsh Wood where the beds were once quarried, is now almost overgrown and detailed collecting is difficult. The topmost beds are not fully exposed, and probably the best continuous exposures through the Stage are those in the Onny Valley, north-north-east of Cheney Longville, where the lowest beds represent a transition from the underlying Upper Longvillian, and comprise brownish-green flaggy siltstones with numerous lenticular shelly bands. The latter are nearly always crowded with fossils, the most abundant of which are *Dalmanella wattsi* and *Tentaculites*, with *Broeggerolithus transiens*, *Brongniartella bisulcata* (Salter) and *Chasmops*. Individuals of the two last-named often attain a large size.

Both lithologically and faunally the succeeding beds resemble those already described, the only conspicuous difference being in the preponderance of *Dalmanella unguis* which, although it overlaps slightly with *D. wattsi*, replaces that species as the characteristic brachiopod. Rare and unusual trilobitic elements in the *D. unguis* Beds of Marshbrook are *Otarion* and *Encrinurus*, the only horizon from which they are known in the Caradoc of south Shropshire. The *D. wattsi* and *D. unguis* Beds exhibit little change in lithology along the strike, but to the north-east of Soudley the latter horizon includes some grey mudstones with abundant and conspicuous ochreous-weathering fossils, such as *D. unguis* and *B. transiens*.

The upper beds of the Cheney Longville Flags consist typically of greenish-yellow flaggy siltstones with lenticular fossil-bands. In the Onny Valley they are followed in the succession by beds of the Actonian Stage, at this, the type-locality, comprising grey mudstones from which cryptolithids are absent, and in which small lamellibranchs, gastropods and cephalopods are dominant. The junction of the two Stages is not usually exposed and there is some difficulty in mapping the precise line of demarcation. In the Onny the highest visible Marshbrookian beds are flaggy siltstones with *Kjerulfina polycyma*; a gap in the exposures supervenes before the Actonian mudstones are seen at Jack Slither. To the north, at Woolston, what may be slightly higher beds with *K. polycyma* are exposed, and there is a partial transition to a finer-grained mudstone lithology, some of the beds being grey as well as the more usual yellowish-brown. Though the complete transition is nowhere entirely exposed, the south-western portion of the track through Marsh Wood, near Marshbrook, affords a good opportunity for further study, even though partly overgrown. Flaggy siltstones, apparently the upper part of the *D. unguis* Beds, are followed by a thin band of mudstone containing abundant worm burrows. Next come mudstones resembling the Actonian beds of the Onny Valley, but containing a fauna which comprises both Marshbrookian and Actonian elements. It includes small lamellibranchs, orthoceratids, *Tropidodiscus acutus*, *Sinuites*, *Broeggerolithus*, *Brongniartella bisulcata*, *Harknessella* (*s.l.*), *Hedstroemina fragilis*, *Sowerbyella sericea* and dalmanellids. Slightly higher in the succession flaggy siltstones containing *K. polycyma* and *Primaspis* cf. *caractaci* are encountered.

The entry of new faunal elements seems to have been at least partly governed by the lithology, and the line between the Marshbrookian and Actonian in south Shropshire probably varied slightly from place to place, depending upon the conditions at any one point. In this instance the transitional beds described are considered to be best included in the Marshbrookian, primarily on account of their content of cryptolithids, which are not found in the Actonian of the Onny Valley. This description casts some doubt on the reliability of *Kjerulfina polycyma* as a zonal index ; it does not usually occur in a mudstone environment, at least in Shropshire, and appears to be restricted to the more arenaceous strata.

(f) *Actonian Stage*

The term Actonian was introduced first by Bancroft (1929*b*, table opposite p. 76) who, without giving definition or details, listed it in a stratigraphical table and subdivided it into two zones, a lower one of *Hedstroemina robusta*, and an upper one of *Resserella* (now *Cryptothyris*) *paracyclica*. The Stage was stated to be represented by part of the Acton Scott Beds of the Horderley District. Subsequently Bancroft again listed the Stage in a stratigraphical table (1933), but on this occasion used only the single brachiopod index of *Onniella grandis*, at that time an undescribed species. Strata in south Shropshire, Westmorland and various parts of North Wales were assigned to the Actonian.

It was not until twelve years later that Bancroft (1945 : 183) defined the base and top of the Actonian, and designated the section exposed in the Onny Valley " east of Burrells Coppice " as constituting the type-succession. His definition of the base as being " marked by the disappearance of *Kjerulfina* and *Tentaculites anglicus*, and the appearance of a large species of *Onniella* and *Colpomya* " is not found to be sufficiently precise in practice, and does not take into account any variation of fauna with environmental changes ; consequently, a detailed re-examination of the type-succession is necessary.

The only place in Shropshire where a reasonably exposed succession through the whole Actonian can be found is in the Onny Valley. Here it is possible, on the basis of their faunas, to divide the beds roughly into three parts as follows, though some difficulties arise when detailed correlation with other parts of the Caradoc Area is attempted.

(i) The lowest Actonian comprises yellow and grey mudstones, with occasional thin, nodular limestones, and shows a lithological transition from the topmost beds of the Marshbrookian. Particularly noticeable is the sudden absence of cryptolithids ; instead, the mudstones of the Onny District were invaded by considerable numbers of *Platylichas laxatus* (McCoy) and *Chasmops*, the latter usually considerably larger than those from earlier strata. *Kjerulfina* has not yet been found in the Actonian of the Onny, though *Hedstroemina* persists into the lowest beds, and the most abundant brachiopod is *Onniella depressa* Bancroft. After a long absence *Heterorthis alternata* (J. de C. Sowerby) returns to form a limestone band several inches thick. The gastropods *Holopea striatella* (J. de C. Sowerby) and *Sinuites* are often abundant, as are the corals *Favosites* and *Coenites*?, though there is no suggestion of reef-conditions having existed.

(ii) The strata of the middle Actonian are marked by a decline in the number of individuals of *Platylichas* and *Chasmops*, though these two genera are not altogether uncommon. They are joined by another phacopid genus *Calyptaulax*, previously unrecorded from Shropshire which, though not abundant, appears to be relatively restricted in its vertical range. *Primaspis* [*Acidaspis*] *caractaci* (Salter) is uncommon in this mudstone environment. Of the brachiopods *Onniella grandis* is not very abundant, but *Cryptothyris paracyclica* and *Reuschella semiglobata* Bancroft are moderately common. All three species appear to be characteristic, but *C. paracyclica* is here preferred to *O. grandis* as index-brachiopod. *Nicolella actoniae* (J. de C. Sowerby), abundant in some other districts of the Caradoc Area, is markedly uncommon in the vicinity of the Onny.

(iii) The faunas of the upper Actonian in the Onny Valley appear to be less prolific than those of the earlier beds, and diagnostic forms are less obvious, though the strata are less well exposed. *Platylichas* and *Chasmops* are very much less abundant, but they are accompanied by numerous *Remopleurides* sp. nov., a few individuals of which first appeared late in the middle Actonian. Of the brachiopods only *Sowerbyella* and *Onniella* are common, but *Dolerorthis*, *Chonetoidea* and *Sampo* (recorded in Shropshire for the first time) occur. *Onniella sinuata* Bancroft is known to be typical of an horizon fairly high in this upper third of the Actonian, but its overall distribution is not yet fully known.

Northwards from the Onny Valley the beds are covered by Drift as far as the neighbourhood of Acton Scott, where strata of Actonian age form the capping to the high ground on which the village is situated. The detailed succession here is much more difficult to follow, as well as being probably less complete, than in the Onny Valley, and it has not been possible to examine fully the lowest beds and their junction with the Marshbrookian. The valley running eastwards from Marshbrook Village exposes strata which are probably rather higher in the Actonian succession. They consist of yellowish-grey, sandy mudstones with a good fauna which includes *Platylichas*, *Primaspis caractaci*, *Remopleurides*, *Chonetoidea*, *Cryptothyris*, *Nicolella actoniae* and *Onniella grandis*, with common small gastropods and lamellibranchs. A reasonable correlation is with the lower part of the middle Actonian of the Onny Valley. The mudstones appear to pass upwards into more arenaceous beds, almost quartzitic sandstones in part, which are more resistant to erosion than the underlying mudstones, and which were once quarried extensively both at and near Acton Scott. The most conspicuous elements of the fauna are *Nicolella actoniae* and *Reuschella bilobata* (J. de C. Sowerby), associated with *Cryptothyris paracyclica* and *Leptaena*. Trilobites also occur and include *Platylichas*, *Chasmops*, *Primaspis caractaci* and *Gravicalymene*, with rare *Illaenus* and *Atractopyge*. Occasional bands of mudstone yield locally abundant ostracods, such as *Tetradella* and *Beyrichia*?. The assemblage suggests that the beds may be equated with part of the middle Actonian of the Onny

Valley. Higher horizons have not yet been confirmed, but this may be due to lack of exposures. The assemblage of *Platylichas*, *Illaenus*, *Atractopyge* and *Nicolella* is interesting in that it occurs at a much lower level in the Derfel Limestone (probably basal Harnagian) of the Bala District (Whittington & Williams, 1955).

In the vicinity of Hatton, north-east of Acton Scott, Actonian beds are exposed in the stream west of the village. The arenaceous strata of Acton Scott are not in evidence, and the succession consists almost entirely of grey mudstones with bands of impure limestone. The fauna is a prolific one, with *Platylichas*, *Chasmops*, *Reuschella bilobata* and *Onniella grandis* in abundance, suggesting a lower to middle Actonian age. The absence of higher beds is almost certainly due to the cover of Drift or to the unconformable Upper Llandovery.

In the banks of Ticklerton Brook, between Ticklerton and Soudley, soft grey mudstones occur below the basal Llandovery strata. Fossils are not abundant but include *Reuschella semiglobata*, and the beds are probably middle Actonian in age. The Marshbrookian/Actonian junction is not exposed in this section.

It has been stated in recent years that strata belonging to Lapworth's Acton Group do not occur to the north of the Cardington Hills (Pocock & Whitehead, 1948 : 51), but many years ago Salter & Aveline (1854 : 66) recorded them from the then well-known fossiliferous locality of Gretton, near Cardington, cited again by Cobbold (1900 : 55). Gretton Quarry, now unfortunately filled in, produced an enormous fauna which clearly indicates a middle Actonian age. The large number of forms found there include *Platylichas*, *Chasmops*, *Illaenus*, *Gravicalymene*, *Calyptaulax*, *Primaspis caractaci*, *Nicolella actoniae*, *Reuschella bilobata*, *Onniella grandis*, *Sampo*, *Cryptothyris paracyclica*, and abundant polyzoans and corals. The beds are soft, yellow, flaggy sandstones with shelly lenses. The underlying and overlying strata are insufficiently exposed for any detailed observations to be made.

(g) *Onnian Stage*

This, the most restricted areally of all the Stages of the Caradoc Series in south Shropshire, was introduced by Bancroft (1929*b*, table opposite p. 76) ; it was divided into three trilobite zones of *Onnia cobboldi*, *O. gracilis* and *O. superba* in ascending order, and stated to occur only in the Onny Valley. Later it was again listed in a tabular succession, but was correlated with strata in both south Shropshire and Westmorland (Bancroft, 1933). In 1945 Bancroft named the Onny Valley as the type-section and gave further details of the Stage (1945 : 183). The base of the Onnian was described as being marked by the appearance of the cryptolithid genus *Onnia*, and the summit by the disappearance of *Onnia* and the reappearance of *Tretaspis kjaeri*, the latter being said to have a limited distribution in the Actonian. *Tretaspis* is known from the Caradoc Series in Westmorland, but there is no evidence that it has been found in south Shropshire.

Examination of the Onnian within the Caradoc Area is hampered by the unconformable cover of Llandovery strata, as well as by extensive Drift deposits, and the only accessible succession is in the Onny Valley south of Wistanstow. In practice

Bancroft's definition of the base has proved convenient ; the preceding Actonian contains no cryptolithids, and their sudden reappearance can be easily followed in the field. The three successive cryptolithid zones erected by Bancroft appear to be well established in the Onny region, but unfortunately their lateral development cannot be traced owing to paucity of exposures.

Lithologically the *Onnia cobboldi* Zone shows no obvious change from the Actonian, but the trilobite fauna differs markedly, although occasional Actonian elements remain. *Platylichas* and *Chasmops*, genera so abundant in parts of the Actonian, occur merely as occasional isolated individuals, and only the former genus has been recorded from the succeeding *Onnia gracilis* Zone. Similarly, illaenids like those of the Actonian are sometimes found. The occurrence of two specimens of *Gravicalymene* in the *O. gracilis* Zone is interesting because it is apparently the same form as is so abundant in some of the Actonian sandstones. The trilobite fauna of the topmost zone of *Onnia superba* is particularly rich in individuals of the zonal cryptolithid, but other forms include *Lonchodomas pennatus* (La Touche), *Raphiophorus edgelli* (Reed), *Remopleurides burmeisteri* Bancroft, *Triarthrus*, *Pseudosphaerexochus* and *Eobronteus*?, the last two being extremely rare. The brachiopod fauna of the two lower zones of the Onnian comprises mainly the genus *Onniella*. *O. inconstans* Bancroft in the *Onnia cobboldi* Zone is followed in the *Onnia gracilis* Zone by the related *Onniella broeggeri* Bancroft, accompanied by abundant small *Chonetoidea* and ostracods.

The strata of the *Onnia superba* Zone would appear to indicate quieter conditions of deposition, and whole trilobites are of frequent occurrence. Coincident with these conditions *Onniella* almost disappears, and the brachiopods usually found are *Chonetoidea* (like that in the Actonian), and the very small " *Rafinesquina* " *holli* (Davidson) which may be locally abundant.

The term Acton Scott Beds was used by Bancroft (1929*b*, table opposite p. 76 ; 1933) to include the Actonian and the two lower trilobite zones of the Onnian, leaving the *Onnia superba* Zone equivalent to the Onny Shales, which is apparently the same usage as that of La Touche (1884). As stated earlier, however, the Acton Scott Beds (*s. s.*) of the Acton Scott District include only part of the Actonian Stage. Furthermore, the sharp colour change between the yellow-weathering mudstones of the *Onnia superba* Zone at the well-known " Cliff Section ", with their limonitic fossils, and the earlier Onnian strata is apparent rather than real, and all the rocks appear as grey mudstones when seen in fresh section. Accordingly, the strata belonging to the Onnian Stage in south Shropshire are here named *Onnia* Beds *nom. nov.*, with the Onny Valley between Cheney Longville and Wistanstow as type-locality.

III. LAPWORTH'S SUBDIVISIONS OF THE CARADOC SERIES

Lapworth (1916) published a series of vertical sections covering the Lower Palaeozoic rocks of Shropshire. He applied the name " Caradoc Series " to the Ordovician rocks forming the elongated outcrop in the Caer Caradoc-Wrekin District and subdivided them to give the following succession :

GRAPT-OLITE ZONE	STAGE	COSTON-HORDERLEY	MARSHBROOK-HENLEY	SOUDLEY-WALLSBANK	THE CWMS-GRETTON	EVENWOOD-HARNAGE
		UPP. LLANDOVERY				
DICRANOGRAPTUS CLINGANI	ONNIAN	ONNIA BEDS	UPP. LLANDOVERY ?ONNIA BEDS AT HENLEY	UPP. LLANDOVERY	UPP. LLANDOVERY ?ONNIA BEDS pars	
DICRANOGRAPTUS CLINGANI	ACTONIAN	GREY MUDSTONES AND LIMESTONES	ACTON SCOTT BEDS s.s.	GREY MUDSTONES OF TICKLERTON	YELLOW SANDSTONES = ACTON SCOTT BEDS	
DICRANOGRAPTUS CLINGANI	MARSHBROOKIAN	U — CHENEY LONGVILLE FLAGS	U — CHENEY LONGVILLE FLAGS	U — CHENEY LONGVILLE FLAGS	CHENEY LONGVILLE FLAGS	
DICRANOGRAPTUS CLINGANI	UPPER LONGVILLIAN	L — CHENEY LONGVILLE FLAGS ALTERNATA LIMESTONE	L — CHENEY LONGVILLE FLAGS ALTERNATA LIMESTONE	L — CHENEY LONGVILLE FLAGS ALTERNATA LIMESTONE	CHENEY LONGVILLE FLAGS ALTERNATA LIMESTONE ?	
DICRANOGRAPTUS CLINGANI	LOWER LONGVILLIAN	U, M — HORDERLEY SANDSTONE	PROBABLE BREAK HORDERLEY SANDSTONE pars	FAUNAL BREAK	UPPER CHATWALL SANDSTONE	
DIPLOGRAPTUS MULTIDENS	SOUDLEYAN	L — HORDERLEY SANDSTONE GLENBURRELL BEDS	NOT SEEN, OWING TO FAULTING	SOUDLEY SANDSTONE ?	LOWER CHATWALL SANDSTONE ?	
DIPLOGRAPTUS MULTIDENS	HARNAGIAN	SMEATHEN WOOD BEDS		HARNAGE SHALES AND NEPTUNIAN DYKES	SHALES 'HOAR EDGE GRITS' OF 'THE CWMS'	UPPER BEDS FAULTED OUT HARNAGE SHALES s.s. SSTS. + SALTEROLITHUS H. SUBQUADRATA LST.
NEMA-GRAPTUS GRACILIS	COSTONIAN	COSTON BEDS, INCLUDING BASAL CONGLOMERATES		URICONIAN (HAZLER HILL): LONGMYNDIAN (LITTLE STRETTON)	LONGMYNDIAN OR TREMADOC	H. SUBPLICATA BEDS SANDSTONES AND SHALES WITH N. GRACILIS

TEXT-FIG. 4.—Correlation of the Caradoc Series in the Type Area.

Acton Group	.	Upper *Trinucleus* Beds Acton Calcareous Beds
Longville Group	.	Lower *Trinucleus* Shales Birrells Wood Flags Chelmick Flags and Shales
Chatwall Group	.	Alternata Limestone Upper Chatwall Sandstone Lower Chatwall Sandstone (*Glyptocrinus* Flags)
Harnage Group	.	Harnage Shales
Hoar Edge Group	.	Transition Bed Upper Hoar Edge Sandstone Hoar Edge Limestone Lower Sandstone and Conglomerate

Lapworth supervised extensive collecting by the Geological Survey from horizons throughout the Series, but the results remained unpublished and the subdivisions listed above were never defined or described. Some use has been made of the terms (Watts, 1925 : 340 ; Pocock *et al.*, 1938 : 81–90) and it is necessary to re-assess them and ascertain their usefulness in the light of present-day knowledge.

Hoar Edge Group

No details having been given in addition to the table, it is difficult to fit the succession into the zonal sequence, but it has been pointed out (Pocock *et al.*, 1938 : 86) that the specimens of *Nemagraptus gracilis* identified from the Evenwood District came from beds containing *Harknessella subplicata* near the top of the Hoar Edge Group, which at that point is only about 100 ft. thick. These beds would, then, coincide at least approximately with Lapworth's Lower Sandstone and Conglomerate, the so-called *Harknessella subquadrata* Limestone above being equivalent to his Hoar Edge Limestone. It is possible, though not certain, that the Upper Hoar Edge Sandstone refers to the Rhynchonellid Grits, the latter, together with the "Transition Bed", being considered Harnagian in age. It is doubtful whether Lapworth's detailed succession can be applied successfully to the southern part of the Caradoc Area.

Harnage Group

As stated earlier, the strata referred to his "Transition Bed" by Lapworth are almost certainly those topmost portions of the Hoar Edge Grits in the Evenwood District which contain *Salterolithus* and are thus of Harnagian age.

The Harnage Shales of the type-area of Coundmoor Brook represent only the *Reuscholithus reuschi* Zone of the Harnagian, the higher zones being cut out by faulting. The Harnage Group, strictly interpreted, cannot therefore include more than the lowest trilobite Zone of the Harnagian. It does not constitute a good stratigraphical subdivision on faunal grounds and is probably best allowed to lapse.

Chatwall Group

The term " *Glyptocrinus* Flags " has already been referred to in the discussion of the Soudleyan Stage, and is considered to be almost exactly equivalent to the *Broeggerolithus soudleyensis* Zone in the Onny Valley, but farther north may include beds of a slightly earlier date. The term appears to be in more general use than that of " Lower Chatwall Sandstone ".

In order to summarize the stratigraphical position of those strata known as the Upper Chatwall Sandstone, it is necessary to examine the succession in the type-area around Chatwall Hall, one-and-a-half miles north-north-east of Cardington. To the north-west of Chatwall Hall the *Glyptocrinus* Flags crop out and have been quarried, for example, 70 yards north-north-west of the Hall, where they consist of dark green flaggy sandstones with deeply-weathered shelly lenses containing abundant *Broeggerolithus* cf. *broeggeri*. These beds appear to pass upwards into more massive maroon and grey-green sandstones, such as those quarried just south-east of Chatwall Farm. From this quarry a narrow cutting has been made, leading south-eastwards to the adjacent crossroads, and at the eastern end of the cutting slightly higher beds have been extensively quarried. These two series of strata have generally been grouped together as the Chatwall Sandstone, and the intermediate beds exposed in the cutting have been described by Robertson (*in* Pocock *et al.*, 1938 : 88). The higher sandstone beds, or Upper Chatwall Sandstone, are followed in the succession by lenticular limestones of the Alternata Limestone series (Upper Longvillian), but there are certain features which make it difficult to accept them without question as being of pre-Upper Longvillian age. For example, the fauna includes *Heterorthis alternata* (J. de C. Sowerby) with abundant large *Sowerbyella sericea* and *Brongniartella bisulcata*, all of which are particularly abundant and characteristic in the lower part of the Upper Longvillian elsewhere in the Caradoc Area. Furthermore, the lithology of the Upper Chatwall Sandstone, comprising soft, yellow-weathering flaggy sandstones with shelly lenses, is quite different from that of the Lower Chatwall Sandstone, and is separated from it by thick bands of conglomerate which often contain abundant gastropods. The problem is not yet satisfactorily resolved, but it is possible that the Upper Chatwall Sandstone may eventually prove to be at least partly Upper Longvillian in age, forming what is virtually an arenaceous development of the basal beds of the Alternata Limestone. The exact horizon of the sandstones below the conglomerates is not yet known, but the possibility of the further extension of the stratigraphical break below the Upper Longvillian which is so apparent at Soudley cannot be excluded.

The Alternata Limestone was placed by Lapworth in his Chatwall Group, but on faunal grounds there can be no doubt that its place is with the Lower Cheney Longville Flags in the Upper Longvillian.

Longville Group

Lapworth's term " Chelmick Flags and Shales " presumably refers to the area of Chelmick, about one mile south-west of Hope Bowdler. The derivation of " Birrells Wood Flags " is less clear, as no such place exists on the present-day

Ordnance maps, but it is here suggested that the name may refer to what is now known as Burrells Coppice, by the south bank of the River Onny, rather less than half-a-mile north of Cheney Longville. It is probably true that the beds near Chelmick are fairly low in what generally are called the Lower Cheney Longville Flags, and those exposed at the eastern end of Burrells Coppice are certainly high in the same group. Owing to lack of good continuous exposures at both places it is difficult to correlate the two subdivisions exactly, and the most practical solution is to allow the two names to lapse, while retaining the term Lower Cheney Longville Flags. The latter has the great merit of possessing a definite type-locality, in the lane leading westwards from Cheney Longville, and the almost continuous section available there does not suggest that further lithological subdivision would be of any great value, though there are certain variations in the faunas.

The " Lower *Trinucleus* Shales " must be taken to represent the whole of what is now regarded as the Marshbrookian Stage, but for a number of reasons the name is highly unsuitable. The Marshbrookian, or Upper Cheney Longville Flags, consists almost entirely of massive and flaggy siltstones and mudstones. Cryptolithid trilobites occur throughout, but certainly not in numbers sufficient to give their name to the beds. Furthermore, no type-locality was ever cited, and the name is best rejected.

Acton Group

Though not defined as such, it is certain that Acton Scott must have been the intended type-locality of the " Acton Calcareous Beds ", which are thus at least approximately equivalent to the Acton Scott Beds (*s. s.*) discussed on p. 211. No type-locality was chosen for the Upper *Trinucleus* Beds, though one can claim that, by implication, they are equivalent to at least part of the Onnian Stage of the Onny Valley.

If the Acton Calcareous Beds and the Upper *Trinucleus* Beds are, in fact, equivalent to the Acton Scott Beds (*s. s.*) and part of the Onnian respectively, then, if they are used in their restricted sense, they cannot be exactly equivalent to the Actonian and Onnian Stages, as it has already been shown that the Acton Scott Beds (*s. s.*) probably represent only a part of the Actonian Stage.

IV. FAUNAL LISTS

Each of the species in the following lists is accompanied by a number, or numbers, followed by a letter, or letters. The former refers to the horizon as indicated in Text-fig. 3 ; the latter refers to the district, or districts, within the Caradoc Area, as listed below.

A.—Coston.
B.—Onny Valley.
C.—Brokenstones, near Horderley.
D.—Marshbrook.
E.—Acton Scott.
F.—Little Stretton.
G.—Soudley-Ticklerton.
H.—The Cwms, near Church Stretton.
K.—Evenwood—Harnage Grange.

Costonian Stage

Favosites fibrilla Smith	2; A, C, K
Polyzoans (various)	2; A, B, C, H, K
Cliftonia cf. *andersoni* Reed	1, 2; A, C, K
Dalmanella sp. (small)	2; A, C
Dinorthis flabellulum (J. de C. Sowerby)	1; A
D. aff. *flabellulum* (J. de C. Sowerby)	2; C, K
Dinorthis sp. A	1; A
Dinorthis sp. B	2; C
Dolerorthis sp.	2; A, C
Glyptorthis ? sp.	2; A
Harknessella jonesi Bancroft	1; A
H. subplicata Bancroft	1; K
H. subquadrata Bancroft	2; K
H. vespertilio (J. de C. Sowerby)	1; A
Harknessella sp.	2; C
Heterorthis patera (Davidson)	1; A: 2; C
Horderleyella plicata Bancroft	2; A, C
Leptaena sp.	2; A, C
Lingula cf. *ovata* McCoy	2; A
Orbiculoidea sp.	2; A
Rafinesquina cf. *complanata* (J. de C. Sowerby)	2; A, K
R. aff. *expansa* (J. de C. Sowerby)	1; A
Rafinesquina sp.	2; A, C
Rafinesquina sp. (? nov.)	2; K
Salopia salteri (Davidson)	2; C
Siphonotreta cf. *micula* McCoy	2; K
Smeathenella strophomenoides Bancroft	2; A, C
Sowerbyella sp.	1, 2; A, C, K
Cyclonema cf. *crebristria* (McCoy)	1, 2; K
Leseurilla balclatchiensis Longstaff	2; K
Liospira aequalis (Salter)	2; K
Rhaphistomina ? sp.	1; A
Hyolithes sp.	2; A, K
Ambonychia sp.	2; K
Ctenodonta cf. *varicosa* (Salter)	1, 2; K
" *Orthoceras* " sp. indet.	2; K
Asaphid indet.	1; A
Brongniartella aff. *bisulcata* (Salter)	2; K
Costonia ultima (Bancroft)	2; A, C
Costonia sp. nov.	2; H. K
Eohomalonotus sp.	2; K
Flexicalymene cf. *acantha* Bancroft	2; A, C
Flexicalymene sp.	1; A: 2; K
Metopolichas ? aff. *verrucosa* (Eichwald)	2; C, K
Reacalymene pusulosa Shirley	1, 2; K
Primitia simplex (Jones)	2; A, K
P. strangulata (Salter)	2; K
Tetradella scripta Harper	2; A, C, K ?

Harnagian Stage

Cystid plates	3 ; B, G, K
Crinoid ossicles	3, 4 ; B : 3 ; K
Lepidocoleus suecicus Moberg	3 ; B, G, K
Plumulites sp.	3 ; B, K
Turrilepas ? sp.	3 ; B
Polyzoans (various)	3 ; B, C, F, G, K
Chonetoidea ? sp.	4 ; B
Cliftonia cf. *andersoni* Reed	3 ; B, C
Dalmanella sp.	3 ; B
Dinorthis sp.	3 ; B, C, F, G
Dolerorthis sp.	3 ; B, G
Harknessella cf. *vespertilio* (J. de C. Sowerby)	3 ; B, G
Heterorthis aff. *patera* (Davidson)	3 ; B, C
Horderleyella sp.	3 ; B
Lingula sp.	3 ; B, K
Orbiculoidea sp.	3 ; B
Orthorhynchula sp.	3 ; B, G
Paterula cf. *albida* Reed	3 ; K
Rostricellula aff. *triangularis* Williams	3 ; B
Salopia salteri (Davidson)	3 ; B, C, F, G
Siphonotreta cf. *scotica* Davidson	3 ; B
Smeathenella harnagensis Bancroft	3 ; B, C, K ?
S. cf. *harnagensis* Bancroft	3 ; B
Sowerbyella aff. *sericea* (J. de C. Sowerby)	3 ; B, C, F, G, K
Vellamo sp.	3 ; G
Carinopsis cf. *gracilis* (Reed)	3 ; K
Cyrtolites sp.	3 ; B, K ?
Phragmolites sp.	3 ; B
Raphistoma sp.	3 ; K
Conularia (*s.l.*) sp.	3 ; B, K
Hyolithes sp.	3 ; B, K
Ctenodonta aff. *coarctata* (Phillips)	3 ; B, K
C. cf. *varicosa* Salter	3 ; B, G, K : 4 ; B
Modiolopsis ? aff. *postlineatus* McCoy	3 ; K
" *Orthoceras* " sp.	3 ; K
Basilicus marstoni (Salter)	3 ; B
Brongniartella sp.	3 ; B, K
Decoroproetus fearnsidesi (Bancroft)	3 ; B, K
D. cf. *fearnsidesi* (Bancroft)	3 ; F
Diacalymene ? *praecox* Bancroft	3 ; B, K
Flexicalymene acantha Bancroft	3 ; B, K
Flexicalymene sp.	3 ; B
Nieszkowskia stubblefieldi Bancroft	3 ; B
Parabasilicus powisi ? (Murchison)	3 ; B
Reuscholithus reuschi Bancroft	3 ; B, G, K
Salterolithus harnagensis Bancroft	3 ; K
S. aff. *harnagensis* Bancroft	3 ; G, H, K
S. smeathenensis Bancroft	3 ; B
S. caractaci (Murchison)	3 ; B, G ?
Primitia nana Jones & Holl	3 ; B, C, G, K
P. simplex (Jones)	3 ; B, G ?, K
Tetradella scripta Harper	3 ; B, C, F, G, K : 4 ; B, G ?
Ulrichia bicornis (Jones)	3 ; B, C, G, K

Soudleyan Stage

Favosites fibrilla Smith	6 ; H : 7 ; B, G
Crinoid ossicles	6 ; H : 7 ; B, G, H
Rhaphanocrinus basalis (McCoy)	6 ; H : 7 ; B, G. H
Cliftonia cf. *andersoni* Reed	6 ; B : 7 ; B, G, H
Craniops sp.	6 ; B : 7 ; B, H
Dinorthis aff. *flabellulum* (J. de C. Sowerby)	7 ; B, G
Heterorthis retrorsistria (McCoy)	6 ; B : 7 ; B, G, H
Horderleyella corrugata Bancroft	7 ; B
Leptaena sp.	6 ; B
Orbiculoidea sp. (small)	6 ; B
Rafinesquina expansa (J. de C. Sowerby)	7 ; B, G ?, H
Rafinesquina sp.	7 ; B
Reuschella horderleyensis Bancroft	7 ; B, G
Soudleyella avelinei (Bancroft)	6 ; B
Sowerbyella sp.	6 ; B, H : 7 ; B, H
Carinopsis cf. *gracilis* (Reed)	7 ; H
Cyclonema crebristria (McCoy)	7 ; B, H
Cyrtolites nodosus (Salter)	7 ; B
Sinuites bilobatus (J. de C. Sowerby)	7 ; B, H
S. soudleyensis Reed	7 ; H
Hyolithes sp.	7 ; H, K
Ctenodonta sp.	6 ; B : 7 ; H, K
Orthonota sp.	6 ; B : 7 ; H
" *Orthoceras* " sp.	6 ; B
Broeggerolithus broeggeri (Bancroft)	6 ; B, H ?
B. constrictus Bancroft	6 ; B
B. soudleyensis (Bancroft)	7 ; B, G, H
Broeggerolithus sp.	6 ; B
Brongniartella sp.	6 ; B, H
Calymenid indet.	6 ; B
Decoroproetus ? sp.	6 ; B, H : 7 ; B, H
Parabasilicus powisi (Murchison)	6 ; B : 7 ; B
Reacalymene cf. *pusulosa* Shirley	7 ; K
Salterolithus sp.	6 ; B
Primitia sp.	6 ; B
Tetradella scripta Harper	6 ; B
Climacograptus antiquus Hall var.	6 ; B
Orthograptus cf. *apiculatus* Elles & Wood	7 ; B

Longvillian Stage

(i) *Lower Longvillian Substage*

Favosites fibrilla Smith	8 a, b, c ; B
Polyzoans (various)	8 a, b, c ; B
Bancroftina typa (Whittington)	8 c ; B
Cliftonia cf. *spiriferoides* (McCoy)	8 b ; B
Dalmanella horderleyensis (Whittington)	8 a ; B
D. indica Whittington	8 b ; B
D. lepta (Bancroft)	8 b ; B
Dinorthis sp.	8 b ; B
Dolerorthis sp.	8 b ; B
Kjaerina hedstroemi Bancroft	8 b ; B

K. horderleyensis Bancroft	8 a ; B
K. intermedia Bancroft	8 a ; B
K. jonesi Bancroft	8 a ; B
K. cf. *jonesi* Bancroft	8 c ; B
cf. *K. richteri* Bancroft	8 c ; B
Leptaena sp.	8 a, b ; B
Lingula sp.	8 b, c ; B
Orbiculoidea sp.	8 c ; B
Rafinesquina sp.	8 c ; B
Resserella canalis (J. de C. Sowerby)	8 a, b, c ; B
Sowerbella soudleyensis Jones	8 a, b, c ; B
Clathrospira ? sp.	8 a ; B
Cyrtolites nodosus (Salter)	8 a, b ; B
cf. *Liospira aequalis* (Salter)	8 a ; B
Lophospira cf. *gyrogonia* (McCoy)	8 a ; B
Murchisonia ? sp.	8 a, b ; B
Sinuites anceps Reed	8 a ; B
S. bilobatus (J. de C. Sowerby)	8 a ; B
S. soudleyensis Reed	8 a, b ; B
Ambonychia ? sp.	8 a ; B
Ctenodonta sp.	8 a ; B
Broeggerolithus globiceps (Bancroft)	8 a, b, c ; B
Broeggerolithus sp.	8 b ; B
Brongniartella bisulcata (Salter) var.	8 a, b ; B
Eohomalonotus sp. (? nov.)	8 b ; B
Phacopidina apiculata (Salter)	8 a, b, c ; B, D
P. aff. *harnagensis* Bancroft	8 a ; B
Parabasilicus powisi ? (Murchison)	8 a ; B
Reacalymene sp. nov.	8 a, b ; B, D

(ii) *Upper Longvillian Substage*

Favosites fibrilla Smith	9 a, b ; B, G
Streptelasma ? sp. indet.	9 b ; B
Lepidocoleus suecicus Moberg	9 b ; B, G
Bancroftina robusta (Bancroft)	9 a ; B
B. aff. *typa* (Whittington)	9 b ; B
Dolerorthis duftonensis (Reed)	9 a, b ; B, G
Harknessella (*s.l.*) sp.	9 b ; B
Heterorthis alternata (J. de C. Sowerby)	9 a ; B, D, G
Kjaerina bipartita (Salter)	9 a ; B, G
K. geniculata Bancroft	9 b ; B
K. typa Bancroft	9 b ; B
Kjaerina sp.	9 b ; B
Lingula sp.	9 a, b ; B
Marionites typa (Bancroft)	9 a ; B, G
Nicolella ? sp.	9 b ; B
Orbiculoidea sp.	9 a ; G
Philhedra drummuckensis Reed	9 a ; G
Platystrophia sp.	9 b ; B
Plectorthis ? cf. *plicatella* Reed	9 b ; B
Rafinesquina sp.	9 b ; B
Schizocrania sp.	9 a ; G
Sowerbyella sericea (J. de C. Sowerby)	9 a, b ; B, D, G

Strophomena grandis (J. de C. Sowerby)	9 a, b; B, G
Trematis punctata (J. de C. Sowerby)	9 a; B, G
Cyrtolites nodosus (Salter)	9 a; G
Lophospira cf. *gyrogonia* (McCoy)	9 a; G
Sinuites soudleyensis Reed	9 a; G
Tentaculites cf. *scalaris* Schlotheim	9 a, b; B, D, G
Ambonychia orbicularis (J. de C. Sowerby)	9 b; B
Ctenodonta aff. *varicosa* Salter	9 a; G
Pterinea sp.	9 a; G
Asaphid indet.	9 a, b; B
Broeggerolithus longiceps (Bancroft)	9 a, b; B, C, G
B. aff. *soudleyensis* (Bancroft)	9 a; G
Brongniartella bisulcata (Salter)	9 a, b; B, D, G
Chasmops sp.	9 b; B
Flexicalymene aff. *caractaci* (Salter)	9 b; B
Phacopidina apiculata (Salter)	9 a, b; B, G
P. cf. *apiculata* (Salter)	9 a; G
Primitia sp.	9 a; G
Tetradella cf. *scripta* Harper	9 a; G

Marshbrookian Stage

Favosites fibrilla Smith	10 a, b, c; B, D
Polyzoans (various)	10 a, b, c; B, D
Craniops sp.	10 c; B
Dalmanella multiplicata (Bancroft)	10 a; B, D
D. unguis (J. de C. Sowerby)	10 b; B, D
D. wattsi (Bancroft)	10 a; B, D
Dolerorthis sp.	10 b; D
Hedstroemina fragilis Bancroft	10 c; B, D
H. parva Bancroft	10 b; B
Heterorthina praeculta Bancroft	10 a, b ?; B, D
Heterorthis alternata (J. de C. Sowerby)	10 c; B
Kjaerina sp.	10 c; B
Kjerulfina polycyma Bancroft	10 c; B, D
K. trigonalis Bancroft	10 b; B, D
K. cf. *trigonalis* Bancroft	10 a; D
Lingula sp.	10 a; D
Lingula sp. (large)	10 a; D
Nicolella cf. *actoniae* (J. de C. Sowerby)	10 a, b, c; D
Onniella reuschi Bancroft	10 c; B, D
Plectorthis ? virgata Reed	10 a, b; B
Reuschella aff. *bilobata* (J. de C. Sowerby)	10 c; B, D
Schizocrania crassa (Salter *non* Hall)	10 a, b; D
Strophomena grandis (J. de C. Sowerby)	10 a, b, c; B, D
Cyrtolites nodosus (Salter)	10 b; D
Sinuites sp.	10 c; D
Tropidodiscus acutus (J. de C. Sowerby)	10 c; D
Conularia (*s.l.*) sp.	10 b; D
Hyolithes sp.	10 b; D
Tentaculites cf. *scalaris* Schlotheim	10 a, b, c; B, D, G
Ambonychia obliqua (J. de C. Sowerby)	10 b, c; D
A. orbicularis (J. de C. Sowerby)	10 a, b, c; D
Ctenodonta sp.	10 c; D

Broeggerolithus transiens (Bancroft)	10 a, b, c; B, D, G
B. cf. *transiens* (Bancroft)	10 c; B, D
Brongniartella bisculata (Salter)	10 a, b, c; B, D
Chasmops sp.	10 a, b, c; B, D
Encrinurus sp.	10 b; D
Flexicalymene caractaci (Salter)	10 b, c; B, D
F. trigonoceps Bancroft	10 a, b, c; B, D
Flexicalymene sp.	10 a, b; D
Lichas (*s.l.*) sp. indet.	10 b; D
Otarion sp.	10 b; D, G
Phacopidina apiculata (Salter)	10 a, b ?; B, D
Primaspis caractaci (Salter)	10 c; D, G ?
Proetus (*s.l.*) sp.	10 b; G
Tetradella cf. *scripta* Harper	10 b, c; D, G

Actonian Stage

Coenites ? sp.	11; B, E, J
Favosites fibrilla Smith	11; B, E, J
Lepidocoleus suecicus Moberg	11; B
Polyzoans (various)	11; B, E, G, J
Chonetoidea sp.	11; B, E, J
Cryptothyris paracyclica (Bancroft)	11; B, E, J
Dolerorthis sp.	11; B
Heterorthis alternata (J. de C. Sowerby)	11; B
Kjaerina sp.	11; B, J
Leptaena sp.	11; B, E, J
Lingula cf. *attenuata* (J. de C. Sowerby)	11; B
Lingula sp.	11; B
Nicolella actoniae (J. de C. Sowerby)	11; B, E, J
Onniella aspasia Bancroft	11; B, E
O. depressa Bancroft	11; B
O. grandis Bancroft	11; B, G, J
O. sinuata Bancroft	11; B
Orbiculoidea cf. *perrugata* (McCoy)	11; B, J
Platystrophia sp.	11; J
Rafinesquina sp.	11; B, E
Reuschella bilobata (J. de C. Sowerby)	11; E, J
R. semiglobata Bancroft	11; B, E ?, G
Sampo sp.	11; B, J
Sowerbyella aff. *sericea* (J. de C. Sowerby)	11; B, E, J
Strophomena grandis (J. de C. Sowerby)	11; E
Trematis punctata (J. de C. Sowerby)	11; B
Triplesia sp.	11; J
Archinacella cf. *oblongata* (Portlock)	11; B
cf. *Clathrospira trochiformis* (Portlock)	11; B
Cyrtolites nodosus (Salter)	11; B
Ecculiomphalus sp.	11; B
Holopea striatella (J. de C. Sowerby)	11; B, J
Sinuites bilobatus (J. de C. Sowerby)	11; B
S. pseudocompressus Reed	11; B
Tropidodiscus acutus (J. de Sowerby)	11; B
Metaconularia cf. *sowerbyi* (de Verneuil)	11; J
M. vesicularis (Slater)	11; B, E, J

Hyolithes sp.	11; B
"*Orthoceras*" sp.	11; B, G
Ctenodonta varicosa Salter	11; E, G
Modiolopsis cf. *modiolaris* (Conrad)	11; B, E
Orthonota cf. *subcylindrica* (McCoy)	11; B
Orthonota sp. (large)	11; E
cf. "*Pectunculus*" *ambiguus* Portlock	11; B
Pterinea sp.	11; B, E
Calyptaulax sp.	11; B, J
Chasmops sp.	11; B, E, J
Flexicalymene cf. *caractaci* (Salter)	11; E
F. laticeps Bancroft	11; B, E
F. salteri Bancroft	11; B ?, E
Gravicalymene sp.	11; E, J
Illaenus sp.	11; B, E, J
Lonchodomas pennatus (La Touche)	11; B, G
Platylichas laxatus (McCoy)	11; B, E, G, J
Primaspis caractaci (Salter)	11; B, E, J
Raphiophorus edgelli (Reed)	11; B
Remopleurides sp. nov.	11; B, E
Beyrichia ? sp.	11; E
Primitia sp.	11; B, E
Tetradella cf. *scripta* Harper	11; E
Diplograptus sp.	11; B
Orthograptus of *truncatus* Lapworth group	11; B

Onnian Stage

Chonetoidea sp.	12, 13, 14; B
Onniella broeggeri Bancroft	13; B
O. inconstans Bancroft	12; B
Onniella sp.	14; B
Orbiculoidea cf. *perrugata* (McCoy)	14; B
"*Rafinesquina*" *holli* (Davidson)	14; B
Sowerbyella sp.	12; B
Raphistomina ? sp.	14; B
Sinuites pseudocompressus Reed	12, 13; B
Sinuites sp.	14; B
Tropidodiscus acutus (J. de C. Sowerby)	12, 13; B
Metaconularia cf. *vesicularis* (Slater)	14; B
Ceratotheca ? cf. *subuncta* Reed	13; B
Colpomya sp.	12; B
Ctenodonta sp.	13; B
Orthodesma sp.	13; B
cf. "*Pullastra*" *speciosa* McCoy	13; B
Orthonota cf. *subcylindrica* (McCoy)	13; B
"*Cyrtoceras*" sp.	14; B
"*Orthoceras*" sp.	14; B
Eobronteus ? sp.	14; B
Flexicalymene onniensis Shirley	13, 14; B
F. aff. *onniensis* Shirley	12; B
Gravicalymene sp.	13; B
Illaenus sp.	12, 13, 14; B
Lonchodomas pennatus (La Touche)	12, 13, 14; B

Onnia cobboldi (Bancroft)	12 ; B
O. gracilis (Bancroft)	13 ; B
O. superba (Bancroft)	14 ; B
Platylichas laxatus (McCoy)	12 ; B
Pseudosphaerexochus sp. indet.	14 ; B
Raphiophorus edgelli (Reed)	12, 13, 14 ; B
Remopleurides burmeisteri Bancroft	13, 14 ; B
Triarthrus sp.	14 ; B
Climacograptus sp.	13 ; B
Orthograptus cf. *apiculatus* Elles & Wood	14 ; B

V. THE CARADOC/LLANDOVERY JUNCTION

The Caradoc and Llandovery strata of south Shropshire are separated by a profound stratigraphical break, the importance of which was not, at first, fully realized. Murchison claimed that the succession in the Onny Valley continued unbroken from the " Caradoc Sandstone " to the Wenlock Shales, and it was left to Salter & Aveline (1854 : 70) to demonstrate the angular break below the Purple Shales (called by them, *Pentamerus* Beds) at the now classic " Cliff Section " in the north bank of the River Onny, one mile south-west of Wistanstow ; this has been described in detail by Whittard (1927 : 749). At different points along the outcrop Llandovery beds rest on different horizons within the Caradoc Series, and in the present account it is convenient to list these from the north to the south of the Caradoc Area.

The succession employed by the Geological Survey for the Llandovery strata (Robertson *in* Pocock *et al.*, 1938 : 106) is as follows :

3. Hughley Shales
2. *Pentamerus* Beds
1. Kenley Grit

Beds 1 and 2 are only local names, and it may be an advantage in the present discussion to follow Whittard (1927 : 738) in adopting stratigraphical terms which are of more general application, such as :

c. Purple Shales
b. *Pentamerus* Beds
a. Arenaceous Beds

The most northerly point of the Caradoc/Llandovery junction is to be found to the south-east of Harnage Grange, about seven-and-a-half miles south-east of Shrewsbury. Here the Arenaceous Beds rest on Costonian strata, successively higher horizons being transgressed as Church Preen is approached, to the south-west of Kenley, where the Upper Longvillian is overlain. Near Plaish, and at Gretton near Cardington, it is unlikely that the Caradoc outcrop includes any horizon higher than the Actonian Stage.

The continuity of the Caradoc outcrop is broken by the Uriconian of Cardington Hill, to the south-south-east of which the *Pentamerus* Beds rest on strata low in the Caradoc sequence, though possibly no lower than Harnagian. The actual contact is obscured by Drift. Farther south-westwards, about two-fifths of a mile east-north-east of Hollies Farm, the highest Caradoc strata are flaggy Marshbrookian siltstones with abundant *Dalmanella unguis* and *Broeggerolithus transiens*. In Ticklerton Brook, and probably also at Hatton, one mile farther south-west, *Pentamerus* Beds overlie mudstones of Actonian age.

As stated earlier, the highest Caradoc beds seen in the Acton Scott District are the Acton Scott Beds (*s. s.*), probably equivalent to the middle part of the Actonian. There is, however, some distance between their outcrop and the conjectured base of the *Pentamerus* Beds; the possibility that a small outcrop of Onnian exists immediately south-east of Acton Scott cannot be ignored, and some support is derived from Salter & Aveline's record of " *Trinucleus* Shales " (? Onnian) at Henley, one mile to the south-south-west. These are not now exposed, and the solid geology here is much obscured by extensive Drift deposits.

Tracing the lower limit of the Llandovery south-westwards, at the River Onny the Purple Shales have overlapped the *Pentamerus* Beds to lie unconformably on the *Onnia superba* Zone of the Onnian. South-west from the Onny the Purple Shales transgress successively lower Caradoc horizons but, as has been shown by Whittard (1927, pl. 57), they are in turn quickly overstepped by the Wenlock Shales. Near Sibdon Carwood these rest on strata of Longvillian age.

Professor Whittard informs me that a boring made in search of water at Aston-on-Clun some years ago proved the presence there of Wenlock Shales. These are not exposed at the surface, but are presumed to overstep the Costonian near the village and rest on Pre-Cambrian rocks (Western Longmyndian). The inlier of Costonian rocks at Coston is bounded on the west by the Church Stretton Fault, and on the east by, presumably, unconformable Wenlock Shales, though these are covered by alluvium of the Clun Valley.

VI. CORRELATION OF THE SHELLY AND GRAPTOLITIC FAUNAS

A great deal of attention has been paid to the problem of fitting the shelly succession of the Caradoc Series into the graptolite-zones, but no attempt has yet proved entirely successful or satisfactory. The graptolite-zones were established in the Lower Hartfell Shales of southern Scotland as follows :

Pleurograptus linearis
Dicranograptus clingani
Climacograptus wilsoni
Climacograptus peltifer
Nemagraptus gracilis

More recently it has been shown by Jaanusson & Strachan (1953 : 695) that the same succession cannot be used satisfactorily for both Scotland and Wales, and that the *C. peltifer* and *C. wilsoni* Zones of the Southern Uplands are replaced by a single Zone of *Diplograptus multidens* in the Welsh area. The succession of graptolite-zones which must be applied to the Caradoc Area is then :

Pleurograptus linearis
Dicranograptus clingani
Diplograptus multidens
Nemagraptus gracilis

The presence of the *N. gracilis* Zone was recognized some years ago when Stubblefield found the zonal graptolite in strata, loosely termed Hoar Edge Grits, which may be referred to the Costonian (1930 : 87). In view of the small thickness of these beds the presence of the whole of the *N. gracilis* Zone is improbable, and the Costonian, even in the thickest development at Coston, may represent only part of the Zone.

One of the fundamental differences in correlation between past works and the present paper lies in the interpretation of the vertical extent of the *D. multidens* Zone. In the Shrewsbury District Memoir (Pocock *et al.*, 1938 : 82) the whole of the Caradoc Series from the base of the Harnage Shales up to, and including, the Cheney Longville Flags was assigned to the *D. clingani* Zone. This correlation made necessary the acceptance of a large stratigraphical break between the Hoar Edge Grits and the Harnage Shales, and the missing *D. multidens* Zone was thought to be represented by Lapworth's so-called " Transition Bed ". In view of the evidence put forward earlier in this paper against the existence of a large break at the base of the Harnage Shales, it is essential to re-examine the foundations upon which the Geological Survey's argument rests.

The graptolite-species recorded from the Harnage Shales of the Evenwood District (Pocock *et al.*, 1938 : 250) are listed below, together with their vertical range according to Elles & Wood (1913 : 516–525) :

	N. gracilis Zone	*D. multidens* Zone	*D. clingani* Zone	*P. linearis* Zone
Climacograptus cf. *brevis* Elles & Wood	×	×	—	—
C. caudatus Lapworth	—	—	×[c]	—
C. minimus Carruthers	—	—	×	×
Dendrograptus sp.	—	—	—	—
Dictyonema cf. *fluitans* Bulman	—	×	—	—
Diplograptus multidens Elles & Wood var. *compactus* Elles & Wood	—	×	×[r]	—
Orthograptus calcaratus (Lapworth) var. *vulgatus* Elles & Wood	—	×[c]	×	—
O. truncatus Lapworth	—	—	×[c]	×
O. truncatus var. *intermedius* Elles & Wood	—	×[c]	×	—
O. truncatus var. *pauperatus* Elles & Wood	—	×	×	×

It can thus be seen that, rather than proving conclusively the *D. clingani* Zone age of the beds, the assemblage suggests at least the possibility of their belonging to the *D. multidens* Zone. According to Stubblefield (*in* Pocock *et al.*, 1938 : 87) the three species which enabled both the Harnage and Chatwall Groups to be referred to the *D. clingani* Zone were *C. minimus*, *O. truncatus* and *O. truncatus* var. *intermedius*. Recorded occurrences of *Climacograptus minimus* suggest this species is more characteristic of the *D. clingani* Zone but, on the other hand, *Orthograptus truncatus* var. *intermedius* is common only in the *D. multidens* Zone. *O. truncatus* itself has often been regarded as characteristic of the *D. clingani* Zone, but nowadays it is known to range from the *D. multidens* Zone upwards into the Ashgillian, with consequent reduction in its value as a zonal index. A factor strongly in support of the *D. multidens* Zone age of the Harnage Shales is that both *O. truncatus* and *O. truncatus intermedius* are found with *D. multidens* and other characteristic forms in the Caradoc mudstones and shales of the Pontesford outcrop, only a few miles west of the Harnage Grange District (Pocock *et al.*, 1938 : 91–92).

Of the other graptolites from the Harnage Shales, *Climacograptus brevis* is confined to the *N. gracilis* and *D. multidens* Zones, and the *Dictyonema* is close to *D. fluitans* from the Aldress Shales of west Shropshire, now known to belong to the *D. multidens* Zone (Whittard, 1955 : 5).

The available evidence for the age of the Harnage Shales thus tends towards assigning them to the *D. multidens*, and not to the *D. clingani*, Zone. Confirmation of this came when Bulman (1948 : 227) discovered *D. multidens* itself in the Harnage Shales of Coundmoor Brook, the type-locality of the Harnagian Stage. The exact place from which the species was collected is unknown but, as the upper beds of the Harnagian are faulted-out at Coundmoor Brook, it may reasonably be assumed that the specimen came from the *Reuscholithus reuschi* Zone. No graptolitic evidence is yet available from the topmost beds of the Hoar Edge Grits, which have yielded *Salterolithus* ; whether the junction between the *N. gracilis* and *D. multidens* Zones should be placed at the extreme base of the Harnagian as now defined (see p. 11) or slightly higher is not clear but, as the thickness of strata concerned is small, the possible error involved is correspondingly slight.

The base of the *D. multidens* Zone having been more or less satisfactorily established, there remains the problem of defining the upper limit of the zone. Apart from the Harnage Shales of the Harnage District, none of the horizons within the Caradoc Series of the type-area has yielded an abundant graptolitic fauna. A few specimens from the Glenburrell Beds of the Onny Valley have been identified by Dr. Isles Strachan as *Climacograptus antiquus* Hall var., and are considered by him to indicate an age earlier than the *D. clingani* Zone. The Caradoc shales of the Pontesford District (Pocock *et al.*, 1938 : 90) belong to the *D. multidens* Zone although they contain, in addition to the zonal graptolite, such forms as *Orthograptus truncatus* and *O. truncatus intermedius*, which were considered to indicate the *D. clingani* Zone when found in the Harnage Shales a few miles to the south-west. Re-examination of the trilobite assemblage at Pontesford shows that it includes the genera *Brongniartella*, *Salterolithus* and *Broeggerolithus*, indicating a Lower Soudleyan age, and the strata containing them can thus be correlated with the upper part of the Glenburrell Beds of the Onny Valley, an horizon which they also resemble lithologically.

Additional graptolitic material from the upper part of the Soudleyan in the Onny Valley has been identified by Dr. Strachan as *Orthograptus* cf. *apiculatus* Elles & Wood, and is probably indicative of a pre-*clingani* Zone age. The material is, however, scanty owing to the arenaceous lithology.

The *D. multidens* Zone therefore should apparently include at least the lower half of the Soudleyan and possibly the whole of that Stage. The massive sandstones of the Lower Longvillian Substage have not yet yielded any graptolites, and their inclusion in the *D. multidens* Zone is uncertain. For the present a provisional line of demarcation between the *D. multidens* and *D. clingani* Zones is drawn between the Soudleyan and Lower Longvillian, though a more convenient level might be at the base of the Upper Longvillian, as this would coincide with a known faunal break within the Caradoc Series in parts of the Caradoc Area. Further graptolitic material will probably enable the margin of error to be reduced considerably, but many difficulties are encountered when most of the strata involved are shallow-water sandstones.

The remaining problem concerns the zonal position of the upper beds of the Series, that is to say, the Actonian and Onnian Stages. The topmost Caradoc strata of the Onny Valley, presumably the *Onnia superba* Zone of the Onnian, were said by Wade (1911 : 445) to contain *Orthograptus truncatus* var. *socialis* Lapworth in abundance, and he accordingly assigned them to the Ashgillian. Bancroft (1933) equated the Actonian with the *Pleurograptus linearis* Zone ; no reasons for this were given, but he may have been influenced by Wade's view that at least part of the Onnian belonged to the Ashgillian. Whittard (1952 : 162) has drawn attention to the conflicting statements made by Bancroft at various times regarding the correlation of the shelly and graptolitic faunas ; these may be summarized as follows. The upper Stages of the series Costonian to Onnian include the *P. linearis* Zone and part or all of the succeeding Zone of *Dicellograptus complanatus*, the basal zone of the Ashgillian in its usually accepted sense (Bancroft, 1945 : 181). The Onnian was said to be succeeded in Westmorland by, first, the Pusgillian Stage, and then the Ashgillian, the latter apparently being used in a restricted sense, though few details were given. In the same paper Bancroft (p. 183) described the Actonian as including "the earliest deposits with *Tretaspis kjaeri*, *Phillipsinella* and other typical Upper Bala fossils", but on a later page (p. 186) caused considerable confusion by claiming that, at Girvan, "the Actonian and Onnian are represented in the series of grey flags with fossiliferous limestones underlying the Zone of *Dicellograptus complanatus* (Pusgillian)". It is thus difficult to see exactly what were Bancroft's views, but his work shows a definite tendency to include in the Ashgillian the Pusgillian Stage and, perhaps also, the Onnian.

During extensive collecting from the upper strata of the Onny Valley Wade's claim that they contain *Orthograptus truncatus* var. *socialis* in abundance has not been substantiated ; indeed, well-preserved graptolites are exceedingly rare in both the Actonian and Onnian. In view of this the shelly faunas, in particular the trilobites, afford the most promising means of assessing the position of the highest Caradoc beds. The assemblage in the Actonian includes *Platylichas*, *Chasmops*, calymenids and raphiophorids, and closely resembles that of the 4bδ Étage, or Upper *Chasmops* Limestone, in southern Norway, an horizon known to belong to the *D. clingani* Zone. As described earlier in this paper, the Onnian follows the Actonian conformably and the faunas of the lower portion include some Actonian elements, so that it would be difficult to claim a much later age for the Onnian. Supporting data comes from the trilobite fauna, including *Triarthrus* and raphiophorids, which resembles one described by Thorslund (1940) from the *D. clingani*

Zone of southern Sweden. A few fairly well-preserved graptolites have been obtained from the Actonian of the Onny, which Dr. Strachan has identified as *Orthograptus* of the *truncatus* group, and *Diplograptus* (*s. s.*) sp. He considers that the last-named cannot be later than the *D. clingani* Zone, and in view of the evidence of the shelly faunas outlined above, the youngest strata of the Caradoc Series in the type-section are concluded to be no later than the *D. clingani* Zone. There is no acceptable evidence for the existence of the *Pleurograptus linearis* or *Dicellograptus complanatus* Zones in the Ordovician of south Shropshire.

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